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Volume Two Number Two

SCHOOL OF MINES AND METALLURGY

UNIVERSITY OF MISSOURI

BULLETIN

March, 1910

1909——CATALOGUE——1910

Rolla, Missouri

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NORWOOD HALL

SCHOOL OF MINES AND METALLURGY

UNIVERSITY OF MISSOURI

THIRTY-NINTH ANNUAL CATALOGUE

Rolla, Missouri

1910

1910

JANUARY.

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MARCH.

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MAY.

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SEPTEMBER.

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OCTOBER.

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NOVEMBER.

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DECEMBER.

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CALENDAR.

1910.

March 14, Monday..... Third Term Begins.

June 1, Wednesday..... Annual Commencement.

June 6, Monday..... Summer School Begins.

July 16, Saturday..... Summer School Ends.

September 3 and 5, Saturday and Monday ..... { Entrance Examinations. Registration for First Term.

September 6, Tuesday..... { First Term Class Work Begins.

December 22, Thursday at 4 p. m.... Christmas Recess Begins.

1911.

January 2, Monday..... { Registration for Second Term.

January 3, Tuesday..... { Second Term Class Work Begins.

February 22, Wednesday..... Holiday.

March 10, Friday..... Second Term Ends.

March 11, Saturday..... { Registration for Third Term.

March 13, Monday..... { Third Term Class Work Begins.

May 26, Friday..... Annual Commencement.

BOARD OF CURATORS.

S. L. Baysinger.....Rolla, Mo.
B. H. Bonfoey.....Unionville, Mo.
P. E. Burton.....Joplin, Mo.
D. R. Francis.....St. Louis, Mo.
J. V. C. Karnes.....Kansas City, Mo.
J. C. Parrish.....Vandalia, Mo.
C. B. Rollins.....Columbia, Mo.
T. J. Wornall.....Liberty, Mo.
C. E. Yeater.....Sedalia, Mo.

OFFICERS OF THE BOARD.

J. V. C. Karnes.....President.
D. R. Francis.....Vice-President.
J. G. Babb.....Secretary.
R. B. Price.....Treasurer.

EXECUTIVE COMMITTEE

of the

SCHOOL OF MINES AND METALLURGY.

S. L. Baysinger.....Rolla.
P. E. Burton.....Joplin.
T. J. Wornall.....Liberty.

OFFICERS OF THE COMMITTEE.

P. E. Burton.....Chairman.
Edw. Kahlbaum .....Secretary.
C. M. Knapp.....Treasurer.

Director of the School,

LEWIS E. YOUNG.

Secretary of the Faculty,

JOHN B. SCOTT.

Registrar,

EDW. KAHLBAUM.

Librarian,

IDA STEVENS GARRETT.

Superintendent of Buildings and Grounds,

ROBERT R. DICKERSON.

FACULTY.

ALBERT ROSS HILL, A. B., Ph. D., LL.D..... *President of the University.*

A. B., Dalhousie University, 1892; Ph. D., Cornell University, 1895; LL. D., University of South Carolina, 1905; Dalhousie University, 1908; Westminster College, 1909.

LEWIS EMANUEL YOUNG, E. M.....*Director.*

B. S. in Mining Engineering, Pennsylvania State College, 1900; E. M., Iowa State College, 1904.

GEORGE REINALD DEAN, C. E.....*Professor of Mathematics.*

C. E., School of Mines, 1890; B. S. in Mathematics and Physics, School of Mines, 1891.

AUSTIN LEE MCRAE, S. D.....*Professor of Physics.*

B. S., University of Georgia, 1881; S. D., Harvard University, 1886.

VICTOR HUGO GOTTSCHALK, M. S.....*Professor of Chemistry.*

B. S. in Chemistry and Metallurgy, School of Mines, 1898; M. S., School of Mines, 1900.

ELMO GOLIGHTLY HARRIS, C. E..... *Professor of Civil Engineering.*

C. E., University of Virgina, 1882.

DURWARD COPELAND, S. B.....*Professor of Metallurgy.*

S. B., Massachusetts Institute of Technology, 1903.

LEON STACY GRISWOLD, A. B.....*Professor of Geology.*

A. B., Harvard University, 1889.

JOSEPH HENRY BOWEN *Assistant Professor of Shop Work and Drawing.*

Graduate, Miller School, Va.

LEON ELLIS GARRETT, B. S..... *Assistant Professor of Mathematics.*

B. S. in General Science, School of Mines, 1901.

FACULTY—Continued.

GUY HENRY COX, B. S., M. A..... *Assistant Professor of Mineralogy and Petrography.*

B. S. in General Science, Northwestern University, 1905; M. A., University of Wisconsin, 1908.

CARROLL RALPH FORBES, E. M..... *Assistant Professor of Mining.*

B. S., Michigan College of Mines, 1902; E. M., Michigan College of Mines, 1903.

LOUIS AGASSIZ TEST, Ph. D..... *Assistant Professor of Chemistry.*

B. M. E., Purdue University, 1894; A. C., Purdue University, 1896; Ph. D., University of Chicago, 1907.

PAUL JULIUS WILKINS, B. S..... *Instructor in Modern Languages.*

B. S., Michigan Agricultural and Mechanical College, 1869.

JOHN BENNETT SCOTT, B. S..... *Instructor in English and Secretary.*

B. S. in General Science, School of Mines, 1907.

BOYD DUDLEY, JR., B. S..... *Instructor in Metallurgy and Ore Dressing.*

B. S. in General Science, School of Mines, 1908.

HORACE THARP MANN, M. S..... *Instructor in Metallurgy.*

B. S. in Mining Engineering, School of Mines, 1908; M. S. in General Science, School of Mines, 1909.

J. TERRENCE MCVEY, C. E.... *Instructor in Civil Engineering.*

C. E., Lehigh University, 1906.

FRANK EDWARD DENNIE, B. S..... *Instructor in Physical Training.*

B. S. in Civil Engineering, Brown University, 1909.

FACULTY—Continued.

FREDERICK WILLIAM BUERSTATTE, B. S..... *Instructor in Drawing.*

B. S. in Mechanical Engineering, University of Wisconsin, 1901.

*EDWARD PHILLIP BARRETT, B. S.....*Instructor in Chemistry.*

B. S. in General Science, School of Mines, 1909.

JOHN PERRY WALKER, JR.....*Assistant in Chemistry.*

DAVID LAWTON FORRESTER.....*Student Assistant in Drawing.*

FRED EDWARD RIEDE.....*Student Assistant in Chemistry.*

WILLIAM GROVER BRANHAM....*Student Assistant in Physics.*

VACHEL HARRY MCNUTT...*Student Assistant in Mineralogy.*

HARMON EDWARD MINOR.....*Student Assistant in Surveying.*

JOHN DEE HARLAN.....*Student Assistant in Ore Dressing.*

ROBERT BRUCE MITCHELL...*Student Assistant in Shop Work.*

CAIRY C. CONOVER.....*Student Assistant in Drawing.*

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*Resigned January 15, 1910.

FACULTY COMMITTEES.

Admission.

Professors Dean, Wilkins, and Griswold.

Athletics.

Professors Bowen, McRae, Test, and Cox.

Buildings, Plant and Grounds.

Professors McRae and Harris.

Degrees.

Professors McRae, Scott, and Dean.

Examinations and Schedule.

Professors Griswold, Bowen, and Garrett.

Graduate Courses.

Professors Gottschalk and Copeland.

Theses.

Professors Harris, Copeland, Griswold, and Forbes.

Undergraduate Courses.

Professors Dean, McRae, Griswold, and Gottschalk.

HISTORY OF THE SCHOOL.

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College and a School of Mines and Metallurgy. The design of these institutions is set forth in the following language:

"**Objects of These Colleges.**—The leading objects of said colleges shall be to teach such branches as are related to agriculture and mining." (Session Acts, 1909, H. B. 870, Section 38.)

The School of Mines and Metallurgy was located at Rolla, Phelps County. Here, in November, 1871, the school was formally opened. The statutes fix the status of the school as one of the Colleges of the State University. Its affairs are under the immediate supervision of an Executive Committee, consisting of three members of the University Board of Curators, selected by that body. The need of general culture as a foundation and accompaniment of specifically technical training, led to the establishment, in 1885, of an Academic Course in compliance with the following Act of the General Assembly:

"**Academic Course of Study, etc.**—That the obligation of the State to the general government, assumed by the acceptance of the land grant of July 2nd, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the board of curators of the University of the State of Missouri shall prescribe and adopt a liberal academic course of study to be taught in the School of Mines and Metallurgy located at Rolla, in addition to the courses now taught in said school, and may confer the degree of bachelor of science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof." (Session Acts, 1909, H. B. 870, Section 38a.)

FINANCES.

The proceeds from the sale of the public lands granted by the General Government amount to about $350,000, which is invested in State certificates of indebtedness bearing 5 per cent interest. The School of Mines receives one-fourth of the yearly income thus accruing.

By an Act of Congress, approved August 30, 1890, commonly known as the "Morrill Bill," the General Government donated to each State and Territory maintaining a college or colleges in accordance with the act of July 2, 1862, $25,000 a year. After deducting one-sixteenth of this fund for the Lincoln Institute, Missouri gives one-fourth of the remainder to the School of Mines.

In 1891, the Government returned to the various States the sums collected from their citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.23, and the Thirty-sixth General Assembly of the State won the gratitude of the friends of higher education by establishing this as a permanent endowment for the State University at Columbia, and the School of Mines and Metallurgy at Rolla. One-fifth of the income from this endowment, amounting to $6,469.58 per annum, is received by the School of Mines.

The Fortieth General Assembly of the State passed an act providing for a tax on collateral inheritances for the benefit of the State University, and the Forty-first General Assembly has provided that one-fifth of the funds derived from this tax shall be appropriated for the benefit of the School of Mines.

ENDOWMENT.

The State endowment of the School of Mines is set forth in the following extracts from the Statutes of Missouri:

"The proceeds of the sale of lands donated to the State of Missouri by the United States for the support of the College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy, by act of Congress, approved July 2, 1863, represented by state certificates of indebtedness, of the following amounts and dates:

July 2, 1883	$242,000.00
November 1, 1883	5,000.00
January 29, 1884	5,000.00
April 19, 1884	35,000.00
April 2, 1885	5,000.00
February 25, 1886	5,000.00
January 1, 1888	5,000.00
December 15, 1888	5,000.00
May 15, 1889	5,000.00
July 1, 1891	5,000.00
May 15, 1893	5,000.00
July 1, 1895	22,881.19
April 9, 1895	5,000.00
Representing a total of	$349,881.19

Now issued or any certificates which may hereafter be issued under any general or special act of the General Assembly; one-fourth of the interest of these funds shall be paid to the Treasurer of the School of Mines and Metallurgy, at Rolla, for the maintenance of said institution."

"The proceeds of sales of lands donated to the School of Mines and Metallurgy, at Rolla, represented by the State certificate of indebtedness of $2,000, dated April 15, 1893, issued under act March 31, 1883, interest on which shall be applied to the maintenance of the School of Mines and Metallurgy, at Rolla."

"The State certificate of indebtedness of $3,000, issued under act of April 1, 1895 (pages 278 and 281, Laws 1895), dated April 1, 1896, four-fifths of the interest to be applied to the maintenance of the State University, at Columbia, and one-fifth to the School of Mines and Metallurgy, at Rolla, and also any other certificates which may hereafter be issued and held in trust for this fund under

any general or special act of the General Assembly." (R. S. 1899, Sec. 10522.)

"The State certificate of indebtedness of $646,958.23, derived from 'direct tax' received from the United States, dated April 1, 1891, issued under act of March 26, 1891, four-fifths of the interest to be applied for the maintenance of the State University, at Columbia, and one-fifth for the School of Mines and Metallurgy, at Rolla." (R. S. 1899, Sec. 10522.)

"All sums collected under the provisions of an Act of Congress, approved August 30, 1890, commonly known as the 'Morrill Bill,' shall be paid as follows: One-sixteenth thereof for the benefit of the Lincoln Institute and one-fourth of the remainder to the Treasurer of the School of Mines, at Rolla, Missouri." (R. S. 1899, Sec. 10533.)

Collateral Inheritance Tax.—"The moneys received by the State Treasurer under the provisions of this article shall be deposited in the State Treasury to the credit of the fund now existing in the State Treasury, and known as the 'State Seminary Moneys,' for the maintenance, support and better equipment of the buildings, apparatus, books, instruction, etc., of the University of the State of Missouri, to an amount not exceeding in any one year the equivalent of one-tenth of one mill for every dollar of the assessed valuation of taxable property of the State for the said year; **Provided**, that one-fifth of all such moneys so received shall be devoted to the use of the School of Mines and Metallurgy, a department of the said University." (Session Acts, 1901, Section 302.)

LOCATION.

The School of Mines is located at Rolla, the county seat of Phelps County, on the St. Louis and San Francisco Railroad, approximately half-way between St. Louis and Springfield.

Rolla is on the crest of the Ozark uplift, at an elevation of eleven hundred forty feet above the sea level, and has an agreeable and notably healthful climate. Its position on a great transcontinental railway system makes it readily accessible.

The school is within easy reach of the important mining districts of the State, which offer splendid facilities for the study of mining geology, mining methods, ore dressing, and mining machinery. Numerous recent improvements, due to the systematic study of Missouri ore deposits, methods of ore treatment, and the extensive development of low-grade lead and zinc ores, have given the school advantages for the application of the theories of geology, mining, and ore dressing to practice.

The smelting industry of the State is very important and every courtesy is extended to the professors and students of the school during their visits to these metallurgical plants. The methods of mining coal and clay can be readily studied in Missouri and the adjoining fields. Numerous clay-working and cement plants in St. Louis and the vicinity offer good opportunity for the study of these important industries. In and about St. Louis are also various chemical plants which are visited from time to time.

CAMPUS AND ATHLETIC FIELD.

The grounds of the School of Mines are situated in the highest part of the City of Rolla, and are over twenty-seven acres in extent. The campus contains beautiful lawns, groves of native oak, and many shade trees.

The Jackling Field has a good baseball diamond, a football gridiron, tennis courts, and a 440-yard running-track. On the athletic field there is a suitable building providing shower-baths and a dressing-room for the various athletic teams.

BUILDINGS.

Rolla Building.

This building was originally built by the City of Rolla as a High School building, but was sold to the State in 1871, and for many years was the principal building of the School of Mines and Metallurgy. It is a brick structure, ninety feet by sixty feet, four stories high, including a working basement. It contains the library, laboratories, drafting rooms, offices, and geological collections of the State Geological Survey, recitation rooms for mathematics and modern languages, toilet, shower baths, and locker rooms.

Chemical Hall.

The main portion of this building was erected in 1885 and two wings were added in 1902. The main building is two stories high and one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five feet by sixty feet and one story high. This entire building, including a large basement, is used for chemistry.

Mining Building and Power Plant.

This building, erected in 1895, is a tile-roof, press-brick structure, and consists of two distinct portions, one containing offices, a class-room, and laboratories—the other comprising a large mill-room and mining laboratory, an engine-room, and a boiler-room. Suitable offices are provided in this building for the professor of mining engineering and for the superintendent of buildings and grounds.

Mechanical Hall.

This two-story brick building, erected in 1901, is one hundred fifty feet by sixty feet and was specially designed for mechanical work. The second floor includes a demonstration lecture room, a shop for bench-work in wood, and a temporary gymnasium. The first floor contains a lathe room for wood-turning, a forge room, a metal-working room, and a stock and tool room.

Each floor is provided with a lavatory and lockers, and an office for the instructor.

Norwood Hall.

The corner stone of this building was laid November 23, 1902, and the building was first used in 1903. It contains adequate quarters for the demonstration offices, and provides lecture and recitation rooms for physics, geology, mineralogy, civil engineering, English, mathematics; also drawing rooms and laboratories for physics, geology, mineralogy, and civil engineering. The school library is located on the first floor of Norwood Hall.

Ore Dressing Building.

This is a three-story gray press-brick building with a basement and two large one-story wings. Two stories and the west wing have been in use since January, 1908, and the east wing was erected in 1909. The building provides quarters for metallurgy and ore dressing.

Director's Residence.

This is a two-story brick and frame building, erected in 1889 and used for a number of years as a student club-house and dormitory.

Athletic Building.

A one-story frame building, thirty-seven by thirty-four feet, formerly used as a wood shop, is now used by the athletic teams and provides dressing rooms, lavatory, and store room for athletic supplies.

Carpenter Shop.

The general repair work of the school and construction of laboratory equipment is carried on in a frame building, ninety feet by twenty-two feet. This building is located west of Mechanical Hall and includes a store room for lumber.

LIBRARY READING ROOM

LIBRARY.

The Library contains nine thousand carefully selected volumes and several thousand pamphlets and bulletins. Good collections of works on engineering, mathematics, chemistry, physics, mining, metallurgy, ore dressing, geology, and mineralogy afford to students an opportunity to pursue an extended course of reading in connection with their class-work. The Library also contains the standard works in English and American poetry, fiction, biography, and history. It is well provided with encyclopedias and works for general reference. All of the important technical periodicals and reports are received regularly, together with general magazines which are of interest to engineers and scientists.

Current and recent technical literature plays such an important part in present-day education that an elaborate card index of technical literature has been provided and is maintained up-to-date. More than 40,000 important articles in transactions of societies, reports, bulletins, and periodicals have been recorded and classified.

The Library is the depository for the maps, drawings, photographs, and lantern slides. A splendid series of several thousand photographs of Missouri mines, mills, and smelters is on file and indexed so that it is easily accessible. Photographs have been secured, from most of the important mining camps, of the work, and the student may supplement the daily lectures by reference to these selected illustrations.

The valuable collection of nearly three thousand maps and drawings is indexed and is used to supplement work in the class room and in the drafting room.

The Library is open from 9 a. m. until noon, from 1 p. m. to 5 p. m., and from 7 p. m. to 9 p. m., daily except Sunday.

ADMISSION.

Under the statutes persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation. Students should have a good liberal education, its elements at least, before beginning technical study. The average age of members of the present Freshman class at entrance was about eighteen years. Specific requirements have been fixed by considerations of the express design of the school—"to promote the education of the industrial classes" in certain branches of engineering—and of the educational opportunities of its intended beneficiaries. The requirements for admission to the Freshman class are as follows:

The applicant must file with the Director a satisfactory certificate of good moral standing.

Admission by Examination.—Applicants for admission, not having diplomas from approved schools, are required to pass, without conditions, examinations in fifteen units, a unit being the equivalent of a year's work in one subject, as given in an approved high school.

Of these fifteen units the following are required: Three units in English, one and one-half units in Algebra, one unit in Plane Geometry, and one-half unit in Solid Geometry. The remaining nine units may be selected from the following list:

Subject.	Maximum.	Minimum.
English	4	3
Algebra	1½	1½
Plane Geometry	1	1
Solid Geometry	½	½
Plane Trigonometry	½	½
History	4	1
Latin	4	1
Greek	3	1
German	3	1
French	3	1
Spanish	3	1
Physics	2	1
Chemistry	2	1
General Biology	2	1
Zoology	2	1
Botany	2	1
Drawing	1	1
Shopwork	1	1
Civil Government	½	½
Physiology	1	1
Physiography	1	1

Mathematics.—The four units which may be offered in mathematics are as follows:

Algebra. One and one-half units. Elementary algebra, including the elementary operations, solution of simple and simultaneous linear equations, factoring, radicals, exponents, quadratic equations, equations containing radicals, imaginaries, simultaneous quadratics, higher equations solved as quadratics, relations of roots and co-efficients of quadratics and higher numerical equations, solution of higher equations by factoring, Horner's method of approximation, binomial theorem for positive integral exponent, ratio and proportion, and logarithms.

While the study of these particular subjects is recommended, it is not expected that the student shall be able to pass an examination on each and every one of them. He must produce evidence, however, of having studied algebra for one and one-half years under a good teacher in an accredited high school.

Plane Geometry. One unit. The work in Plane Geometry must cover a full year in any good text. It is recommended that considerable attention be paid to the applications of the algebra to geometry, and of goemetry to algebra and arithmetic.

Solid Geometry. One-half unit. A full half-year's work is required in Solid Geometry. The same recommendations apply here as in Plane Geometry, with the additional requirement that the student be drilled in arithmetical work in computing areas and volumes.

Trigonometry. One-half unit. It is to be understood at the outset that this work will not be accepted for advanced standing. This branch of mathematics is of such great importance to the practical engineer that the whole subject must be reviewed, and the student led to a point of view which it is impossible to attain in a high school course.

English.—The four units that may be offered in English include grammar, composition and rhetoric, and literature.

The candidate will be required to show a reasonable pro-

ficiency in the principles of English grammar, including sentence-analysis. He will be required to show the ability to express himself coherently and correctly, with a fair mastery of the forms of writing, spelling and punctuation, sentence and paragraph structure. He will be examined on the literature listed below, and, if he desires four units, will be required to show also a knowledge of the history of English literature.

The classics prescribed are as follows:

I. For Study and Practice. Shakespeare's *Macbeth;* Milton's *Lycidas, Comus, L'Allegro* and *Il Penseroso;* Burke's *Speech on Conciliation* or Washington's *Farewell Address,* and Webster's *First Bunker Hill Oration;* Macaulay's *Life of Johnson* or Carlyle's *Essay on Burns.*

II. For Reading. Group 1 (two to be selected): Shakespeare's *As You Like It; Henry V.; Julius Caesar; The Merchant of Venice; Twelfth Night.*

Group 2 (one to be selected): Bacon's *Essays;* Bunyan's *The Pilgrim's Progress,* Part I.; Addison's *Sir Roger de Coverley;* Franklin's *Autobiography.*

Group 3 (one to be selected): Chaucer's *Prologue;* Spenser's *Faerie Queene* (Selections); Pope's *The Rape of the Lock;* Goldsmith's *The Deserted Village;* Palgrave's *Golden Treasury* (First Series), Books II. and III., with especial attention to Dryden, Collins, Gray, Cowper, and Burns.

Group 4 (two to be selected): Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* Scott's *Quentin Durward;* Hawthorne's *House of the Seven Gables;* Thackeray's *Henry Esmond;* Mrs. Gaskell's *Cranford;* Dickens' *A Tale of Two Cities;* George Eliot's *Silas Marner;* Blackmore's *Lorna Doone.*

Group 5 (two to be selected): Irving's *Sketch Book* (Selections); Lamb's *Essays of Elia;* DeQuincey's *Joan of Arc* and *The English Mail Coach;* Carlyle's *Heroes and Hero Worship;* Emerson's *Essays* (Selected); Ruskin's *Sesame and Lilies.*

Group 6 (two to be selected): Coleridge's *The Ancient Mariner;* Scott's *The Lady of the Lake;* Byron's *Mazeppa* and *The Prisoner of Chillon;* Palgrave's *Golden Treasury* (First

Series), Book IV., with especial attention to Wordsworth, Keats, and Shelley; Macaulay's *Lays of Ancient Rome;* Poe's *Poems;* Lowell's *The Vision of Sir Launfal;* Arnold's *Sohrab* and *Rustum;* Longfellow's *The Courtship of Miles Standish;* Tennyson's *Lancelot and Elaine, The Passing of Arthur, Gareth and Lynette;* Browning's *Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Evelyn Hope, Home Thoughts from Abroad, Home Thoughts from the Sea, Incident of the French Camp, The Boy and the Angel, One Word More, Herve Riel, Pheidippides.*

History.—Four units may be offered in history; one each in Ancient History, Medieval and Modern History, English History, and American History.

Civil Government. One-half unit may be offered in Civil Government. This is the equivalent of one-half year's work in the fourth year of a high school and the applicant should have a knowledge of the chief organs of local, state, and national government, and a knowledge of the historical development of the government.

Physiography.—A student may offer one unit in physiography. A description of this unit will be sent on request.

Physics.—The two units that may be offered in physics are as follows:

1. A year's work, five periods per week, of which at least two must be double periods in individual laboratory work. At least thirty-five exercises, selected from a list of sixty or more, equivalent to those recommended by the National Educational Association, must be completed.

2. A continuation of the laboratory for another year, or a year's work in a more advanced text together with the laboratory work.

Laboratory note-books must be presented by those who are required to take the entrance examination.

Drawing.—One unit may be offered in drawing and is as follows:

A year's thorough work in freehand drawing, or in mechanical drawing, or in a combination of the two. This unit is the equivalent of five laboratory periods per week throughout the year. Drawings must be presented by students desiring credit in this subject for entrance. This unit will be accepted for admission but not for advanced standing.

Freehand. The ability to draw and paint natural growths (leaves, flowers); to give correct proportions, perspective, and light and shade in drawing from geometric solids, vases, etc.; to paint with water colors from simple objects (fruit vases); to make designs suitable for book covers and school programs, in black and white and in color.

Mechanical. Use of instruments and plain lettering; simple geometrical problems; plain freehand lettering and dimensioning; plans, elevations, and cross-sections; development of the *idea of plan, elevation* and *section* from geometrical solids; drawing accurately to scale plans, elevations, and sections from pupil's own measurements; and dimensioned freehand sketches of simple machine parts; plan and elevation of some building measured by pupils. The explanation and practice of isometric and cabinet views as applied especially in joinery.

Combination. The ability to draw, as outlined under the Freehand Course, without the painting; the use of the instruments, plain lettering, the drawing of simple plans and elevations as outlined under the Mechanical Course.

Manual Training.—One unit may be offered in manual training and the candidate must give satisfactory evidence of having completed a year's work of five periods per week of at least one and one-half hours each. This work will not be accepted for advanced standing.

Latin.—The four units that may be offered in Latin are as follows:

1. Collar and Daniell's First Latin Book, or the equivalent.

2. Three books of Caesar's Gallic War with composition based thereon in Moulton and Collar's Preparatory Latin Composition or in Daniell's New Latin Composition. For one book of the Gallic War the equivalent in time of Viri Romae, Nepos, or Eutropius may be offered.

3. Two additional books of the Gallic War and four Orations of Cicero with compositions based thereon in the books mentioned above.

4. Ovid's Metamorphoses (2,000 lines) and four books of Virgil's Aeneid, with prosody.

Greek.—The three units that may be offered in Greek are as follows:

1. Ball's Elements of Greek, or White's First Greek Book.

2. Four books of Xenophon's Anabasis, Pearson's Greek Prose Composition, or its equivalent, Goodwin's Greek Grammar.

3. Ten orations of Lysias and the first four books of Homer's Odyssey, or an equivalent amount of other Greek authors. Bridgman's Parallel Exercises based on Lysias.

German, French, Spanish.—Three units may be offered in German, French, or Spanish. A description of the units will be sent on request.

Chemistry.—The two units that may be offered in chemistry are as follows:

1. A year's work in chemistry, five periods per week, of which at least two must comprise laboratory work.

2. A second year's work in the subject, five periods per week, of which at least two must be laboratory work.

Note-books showing work done must be presented by those who are required to take the entrance examinations.

These courses will be accepted for admission but not for advanced standing.

Admission on Diploma.—Applicants may be admitted upon certificate from a college, high school, or preparatory school when the Faculty is satisfied that the work certified to covers the requirements of the School of Mines and Metallurgy.

Each applicant must file with his diploma a statement, on a School of Mines and Metallurgy blank, from his superintendent or principal, showing that the applicant has to his credit fifteen units.

Following is a list of schools whose courses have been approved by the University, and whose diplomas will admit to the Freshman class without examination.

ACCREDITED SCHOOLS.

Albany High School
Alton (Ill.) High School
Appleton City Academy
Aurora High School
Bartlesville (Okla.) High School
Belton High School
Bethany High School
Bevier High School
Blees Military Academy, Macon
Bonne Terre High School
Boonville High School
Bowling Green High School
Braymer High School
Breckinridge High School
Brookfield High School
Butler High School
Cairo (Ill.) High School
California High School
Cameron High School
Campbell High School
Carleton College
Carrollton High School
Carterville High School
Carthage High School
Caruthersville High School
Centralia High School
Charleston High School
Christian College
Chillicothe High School
Clinton High School
Columbia High School
Covington (Ind.) High School
Culver (Ind.) High School
Davenport (Ia.) High School
De Soto High School
Dexter High School
Doniphan High School
East St. Louis (Ill.) High School
Elmwood Seminary
Enid (Okla.) High School
Excelsior Springs High School
Fayette High School
Ferguson High School
Flat River High School

VIEW ON THE CAMPUS

Fort Scott (Kan.) High School
Fort Smith (Ark.) High School
Fredericktown High School
Fulton High School
Gallatin High School
Grant City High School
Greenfield High School
Greenville (Miss.) High School
Guthrie (Okla.) High School
Hamilton High School
Hannibal High School
Hardin College, Mexico
Harrisonville High School
Higginsville High School
Holden High School
Hopkins High School
Hot Springs (Ark.) High School
Huntsville High School
Iberia Academy
Independence High School
Jackson High School
Jackson Military Academy
Jefferson City High School
Joplin High School
Kahoka High School
Kansas City Central High School
Kansas City Manual Training School
Kemper Military Academy, Boonville
Kennett High School
Keokuk (Ia.) High School
Kewanee (Ill.) High School
Kidder Institute
King City High School
Kirksville High School
Kirkwood High School
Knobnoster High School
Lamar High School
Lancaster High School
Leavenworth (Kan.) High School
Lebanon High School
Lee's Summit High School
Lexington High School
Liberty High School
Lockwood High School
Logan County High School (Guthrie, Okla.)
Louisiana High School
Macon High School
Maitland High School
Malden High School
Marionville Collegiate Institute
Marshall High School
Maryville High School
Memphis High School
Mexico High School
Missouri Wesleyan College
Moberly High School
Monett High School
Montgomery City High School
Mound City High School
Mt. Vernon High School
Muskogee (Okla.) High School
Neosho High School
Nevada High School
New London High School
Norborne High School
Odessa High School
Oklahoma City (Okla.) High School
Okmulgee (Okla.) High School
Oregon High School
Palmyra High School
Paola (Kan.) High School
Paris High School
Pierce City High School
Pine Bluff (Ark.) High School
Plattsburg High School
Pleasant Hill High School
Poplar Bluff High School
Princeton High School
Quincy (Ill.) High School
Rich Hill High School
Richmond High School
Ridgeway High School
Rock Port High School
Rolla High School

St. Charles High School
St. Charles Military Academy
St. Joseph High School
St. Louis Central High School
St. Louis McKinley High School
St. Louis Manual Training School
St. Louis Yeatman High School
Salisbury High School
Savannah High School
Sedalia High School
Shelbina High School
Shelbyville High School
Sikeston High School
Slater High School
Smith Academy
Springfield High School
Steelville High School
Sweet Springs High School
Synodical College (Fulton)
Tipton High School
Trenton High School
Troy High School
Tulsa (Okla.) High School
Unionville High School
University Military Academy (Mobile, Ala.)
Van Buren (Ark.) High School
Vandalia High School
Walther College, St. Louis
Warrensburg High School
Washington High School
Webb City High School
Webster Groves High School
Wellston Station High School, St. Louis
Wentworth Military Academy, Lexington
West Plains High School
Western Military Academy
Westport High School
William Woods College, Fulton
Windsor High School

Advanced Standing.—Candidates may be admitted to advanced standing either upon examination in the subjects of the previous year or years, or upon certificate from another institution, of work accomplished, which is, in the estimation of the Faculty, equivalent to that completed here by the class into which entrance is sought. Applicants for advanced standing should communicate with the Director as early as possible, and all claims for advanced standing, in order to receive recognition, must be made by the student within one term after entrance.

Special Students.—Special students will be admitted without passing the regular examinations required for entrance, under the following conditions: 1. They must be at least twenty-one years of age. 2. They must show good reasons for not taking a regular course. 3. They must pass such examinations or other tests as shall demonstrate fitness to pursue profitably all the subjects selected by them. 4. They shall not be candidates for a degree. 5. Special students are

expected to do particularly good work in the subjects which they choose. If, at any period of the session, their work becomes unsatisfactory, their connection with the school will be severed. When the work is chiefly of a laboratory nature they will be required to take at the same time as much classroom work as the Faculty may designate for each particular case.

Since there are many persons who would profit by the opportunities for education offered at the school, but who are unable, through lack of time or preliminary training, to undertake the work of the regular course, the Faculty has made the above provision. In this way it hopes to broaden the usefulness of the school, and to enable it to fulfill its purpose in as liberal a manner as possible.

UNDERGRADUATE COURSES.

It is the object of the instruction at this institution, first, to lay a broad and solid foundation by acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and field. Lectures and recitations are arranged for the morning hours, leaving the afternoon for laboratory and field work. The practical work is designed to illustrate and impress principles, to familiarize the student with the use of instruments with which he is to be concerned in the work of his profession, and to afford an opportunity for original investigation. What is taught orally in the lecture room is applied and illustrated in the laboratory.

The School of Mines offers four regular courses leading to degrees.

I. **Mining Engineering.**

II. **Metallurgy.**

III. **Civil Engineering.**

IV. **General Science.**

The first is a general course in Mining Engineering having in view all of the operations in connection with mining, from the prospecting to the delivery of the finished product on the market. Instead of the regular work outlined for the Senior year in the Mining Engineering course, a student who has satisfactorily completed the work of the first three years of this course may elect one of the three optional courses outlined on pages 38, 39 and 40. These options are in Mining Geology, Mining Machinery, and Ore Dressing. They are planned for men who desire to specialize in the particular subjects mentioned and all lead to the degree of Bachelor of Science in Mining Engineering.

The second course contemplates especially processes in metallurgy subsequent to the delivery of the ore above ground. It fits a man for positions in connection with concentrating plants and smelters and various branches of industrial chemistry.

The third is a course in engineering as applied especially to railways, highways, and municipal works.

The fourth is largely elective and provides for a liberal education in General Science.

The engineering courses are practically the same in the Freshman year, and differ but slightly in the Sophomore year. The student has thus an opportunity to defer his choice of a specialty until he has spent some time in technical study, and can better estimate his inclinations and capacities.

One hour is given to each recitation or lecture period. The afternoon periods are given to drawing, laboratory, and field work and are of three hours' duration.

GRADUATE COURSES.

The School of Mines offers graduate work in Mining Engineering, Metallurgy, Ore Dressing, Geology, Economic Geology, Petrography, and Advanced Chemistry. The attention of graduates of engineering schools and of mining schools is directed to the following courses:

Mine Management
Mining Machinery
Mining Machinery Laboratory
Mining Machinery Problems
Mining Law and Contracts
Mine Examination and Reports
Mine Plant
Mine Plant Design
Mining Economics
Mining Research
Economic Geology
Geology of the United States
Structural and Metamorphic Geology
Paleontology
Historical Geology
Petrography
Petrography Laboratory
Cement and Concrete Structures
Compressed Air
Engineering Designs
Ore Dressing Laboratory
Ore Dressing Problems
Ore Supply
Metallurgy Organization
Metallography
Constitution of Alloys
Metallurgical Problems
Metallurgical Plant
Metallurgical Plant Design
Cyaniding
Electro-Metallurgy
Electro-Metallurgy Laboratory
Metallurgical Research
Electro-Chemistry
Slag Analysis
Metallurgical Analysis
Technical Analysis
Physical Chemistry
Theoretical Chemistry
Advanced Physico-Chemical Laboratory
Internal Combustion Engines

Graduates from the four-year course in Mining Engineering may pursue graduate work leading to the degree of Mining Engineer. This fifth year course is outlined on page 46. Electives may be chosen along any line aproved by the Faculty.

A similar graduate course in Metallurgy is outlined on page 47. This course leads to the degree of Metallurgical Engineer.

Graduates in Civil, Electrical, and Mechanical Engineering, who desire to specialize in Mining, may secure the degree of Engineer of Mines by completing the course of study outlined on page 48. Considerable latitude will be granted men who are qualified to undertake research work.

SPECIAL COURSES.

In addition to the four regular courses leading to degrees, mentioned above, a number of shorter courses are also offered. They are: *Chemistry and Assaying, Mining, Surveying and Electricity.* They have been planned for the benefit of those who, for various legitimate reasons, are unable to take the regular four-year courses.

The course in *Assaying and Chemistry* requires two years' work, although mature students, who have already some knowledge of chemistry, may complete it in one year.

The purpose of the course in *Surveying* is to develop competent land and mining surveyors and fair draftsmen. The essentials of it are a thorough knowledge of algebra, trigonometry, surveying, field practice, and drawing. One school year and the first term of a second will be required for the completion of this course.

A short course in *Mining* is offered to students, especially such as have had some practical experience, who may wish to fit themselves for holding important positions about mines or in ore-dressing plants, but who are unable, on account of the lack of preparation or of time, to take the full course in Mining Engineering. Besides mathematics this course includes general chemistry, assaying, mineralogy, geology, mining, surveying, and English.

A course in *Electricity* is offered to furnish the student with the theory of electricity, and acquaint him with its application in the arts. This subject is of great importance to every engineer, especially to the mining engineer, since electricity has become such an important factor in mining operations.

EXCURSIONS.

Required.

A.—At the close of the Sophomore year, three weeks of summer field work for practice in topography and lines of communication is required of students in Civil Engineering. This work is carried on in the vicinity of Rolla.

B.—At the opening of the school year, in September, one week's field work in Topography by all Juniors not taking A.

C.—At the close of the Junior year, students in Mining and Metallurgical Engineering make a three weeks' excursion to southeast Missouri, for practice in mine surveying and the study of field and economic geology, mining, and ore dressing.

D.—During the Senior year a one week's trip to southwest Missouri, particularly the Joplin district, for the study of ore deposits, mining methods, and ore dressing.

E.—Excursions by the Senior class to Steelville, Sligo, DeCamp, Meramec, Newburg, and Sullivan for the purpose of studying iron, copper, lead deposits, and methods of reduction. This excursion takes place during the latter part of the Senior year.

F.—An excursion by the Senior class to Herculaneum, St. Louis, Granite City, and the coal fields of Illinois. This excursion is made during the latter part of the Senior year.

Voluntary.

In addition to the foregoing trips which are required in the various courses, a number of optional excursions can be made under the supervision of the members of the Faculty. These excursions are planned for students who have finished the work of the Junior year and may be made to the following mining districts:

1.—Southern Appalachian District, where geology, mining, and metallurgy may be studied, particularly in the mining districts of Birmingham, Ala., and Ducktown, Tenn.

2.—Copper mining districts of the Southwest, particularly Bisbee, Ariz., and Cananea, Mexico.

3.—Lake Superior mining district, including the copper and iron ranges of Michigan and the iron ranges of Minnesota.

4.—Metal mining districts of Colorado, Utah, and Montana.

THESES.

All Seniors carry on special investigations during the third term and the results of this work are embodied in a thesis. The subject of the thesis must be reported to the Thesis Committee and approved not later than February 1st and the completed thesis filed with the Director not later than May 20th. The finished thesis must be typewritten on eight and one-half by eleven-inch paper with a one and one-half inch margin on the left to permit of binding in book form.

DEGREES.

1. The degree of Bachelor of Science in Mining Engineering, Bachelor of Science in Metallurgy, or Bachelor of Science in Civil Engineering, will be conferred on students who have attained the required standard in all the subjects of instruction in Course I., II., or III., and who submit a satisfactory thesis.

2. The degree of Bachelor of Science will be conferred on students who have satisfactorily completed Course IV., and who submit a satisfactory thesis.

3. The degree of Master of Science will be given to students who, having graduated in Course IV., complete satisfactorily a year's post-graduate work in residence at the school, and demonstrate their ability by research work and a thesis.

4. The degree of Engineer of Mines, Civil Engineer, or Metallurgical Engineer, will be conferred on one who, having previously been graduated in Course I., II., or III., has completed satisfactorily a year's post-graduate work in residence, or who has had professional experience in a responsible position for not less than three years. A satisfactory thesis recording the result of some original investigation or independent research in a subject connected with his course, accompanied by such drawings as may be necessary to illustrate it, are required of all candidates for advanced degrees.

COURSE I.—MINING ENGINEERING.

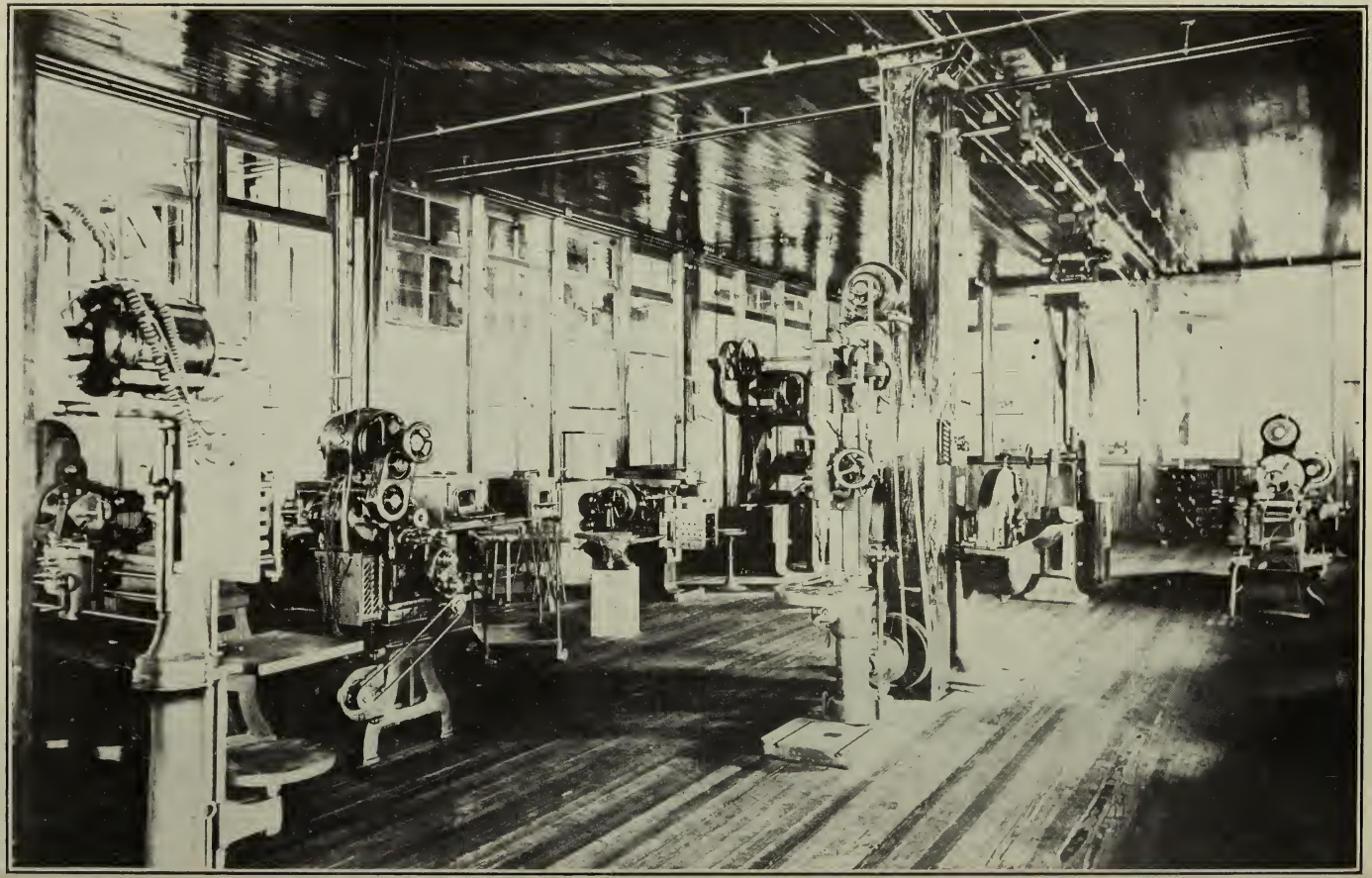
	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FRESHMAN YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	—	—
Plane Trigonometry	—	5	—
Spherical Trigonometry / Analytical Geometry	—	—	5
Descriptive Geometry	—	2	2
General Chemistry	5	5	4
English	5	5	5
Elementary Mining	2	—	—
Mineralogy	—	—	2
LABORATORY WORK:			
General Chemistry	3	3	3
Drawing, Mechanical	6	6	6
Descriptive Geometry Drawing	—	3	3
Shop Practice	6	6	—
Mineralogy Laboratory	—	—	6
SOPHOMORE YEAR.			
LECTURES AND RECITATIONS:			
Analytical Geometry / Differential Calculus	5	—	—
Spanish, German, or French	5	5	5
Advanced English	1	1	1
Integral Calculus	—	5	—
Differential Equations	—	—	5
Mineralogy	2	—	—
Lithology	—	2	—
Plane Surveying	3	—	—
Mine Surveying	—	—	3
Mining	2	2	—
Elementary Mechanics	—	2	—
General Physics	—	—	5
Qualitative Analysis	—	2	—
LABORATORY WORK:			
Forge Shop or Machine Drawing	6	6	6
Mineralogy	6	6	—
Lithology	—	3	—
Surveying Field Practice	6	—	—
Qualitative Analysis	—	6	6
Physics	—	—	6
Topography, one week between the Sophomore and Junior Years.			

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
JUNIOR YEAR.			
LECTURES AND RECITATIONS:			
General Physics	5	—	—
Thermodynamics	—	5	—
Mechanics of Engineering	5	—	—
Mechanics of Materials	—	5	—
Hydraulics	—	—	5
General Geology	5	3	5
Quantitative Analysis	2	—	—
Assaying	2	—	—
Metallurgy	—	3	3
Masonry	—	2	—
Lines of Communication	—	—	2
Elements of Ore Dressing	—	—	3
LABORATORY WORK:			
Physics	6	—	—
Steam	—	3	—
Assaying	6	6	—
Quantitative Analysis	6	9	—
General Geology	—	3	6
Drawing and Graphics	—	—	6
Lines of Communication	—	—	3
Hydraulic Problems	—	—	3
Excursion to Southeast Missouri.			
SENIOR YEAR.			
LECTURES AND RECITATIONS:			
Ore Dressing	4	4	4
Ore Dressing Memoirs	—	—	1
Mining Law and Contracts	2	—	—
Mine Management	—	—	2
Metallurgy	4	4	4
Metallurgy Conference	—	1	—
Economic Geology	3	3	5
Dynamo Machinery	3	—	—
Alternating Current Machinery	—	5	—
Electrical Transmission	—	—	3
Compressed Air	—	2	—
Frame Structures	2	—	—
Hydraulic Motors and Pumps	—	—	1
LABORATORY WORK:			
Ore Dressing	6	—	—
Ore Dressing Problems	—	3	3
Graphics	3	—	—
Dynamo Machinery	6	—	—
Alternating Current Machinery	—	6	—
Electrical Problems	—	—	3
Metallurgy	—	7	—
Compressed Air	—	3	—
Thesis	—	—	6
Senior Trips.			

MINING GEOLOGY OPTION.

SENIOR YEAR.

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
LECTURES AND RECITATIONS:			
Economic Geology	3	3	5
Petrography	3	3	2
Geology of the United States	3	—	—
Structural and Metamorphic Geology	—	—	3
Metallurgy	4	4	4
Geological Conference	—	2	—
Ore Dressing	4	4	—
Mining Law and Contracts	2	—	—
Methods of Prospecting and Mine Development	—	3	—
Mine Management	—	—	2
Elective Geology	—	—	3
LABORATORY WORK:			
Geology	3	6	6
Petrography	9	6	6
Ore Dressing	6	—	—
Metallurgy	—	6	—
Thesis	—	—	6
Senior Trips.			



MACHINE SHOP

MINING MACHINERY OPTION.

SENIOR YEAR.

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
LECTURES AND RECITATIONS:			
Ore Dressing	4	4	4
Ore Dressing Memoirs	—	—	1
Mining Machinery	—	4	5
Dynamo Machinery	3	—	—
Alternating Current Machinery	—	5	—
Electrical Transmission	—	—	3
Compressed Air	—	2	—
Hydraulic Motors and Pumps	—	—	1
Mine Management	—	—	2
Mining Law and Contracts	2	—	—
Economic Geology	3	—	—
Metallurgy	4	4	—
Metallurgy Conference	—	1	—
Frame Structures	2	—	—
Cement and Concrete Structures	—	—	2
LABORATORY WORK:			
Mining Machinery	3	9	—
Mining Machinery Problems	—	—	6
Graphics	3	—	—
Dynamo Machinery	6	—	—
Alternating Current Machinery	—	6	—
Electrical Problems	—	—	3
Ore Dressing	6	—	—
Metallurgy	—	4	—
Compressed Air	—	3	—
Thesis	—	—	6
Senior Trips.			

ORE DRESSING OPTION.

SENIOR YEAR.

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
LECTURES AND RECITATIONS:			
Ore Dressing	4	4	4
Ore Dressing Memoirs	—	—	1
Mining Law and Contracts	2	—	—
Mine Management	—	—	2
Metallurgy	4	4	4
Metallurgy Conference	—	1	—
Economic Geology	3	3	5
Dynamo Machinery	3	—	—
Alternating Current Machinery	—	5	—
Electrical Transmission	—	—	3
Compressed Air	—	2	—
Frame Structures	2	—	—
Hydraulic Motors and Pumps	—	—	1
LABORATORY WORK:			
Ore Dressing	9	—	6
Ore Dressing Problems	—	3	3
Graphics	3	—	—
Dynamo Machinery	6	—	—
Alternating Current Machinery	—	6	—
Electrical Problems	—	—	3
Metallurgy	—	7	—
Compressed Air	—	3	—
Thesis	—	—	6
Senior Trips.			

COURSE II.—METALLURGY.

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FRESHMAN YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	—	—
Plane Trigonometry	—	5	—
Spherical Trigonometry / Analytical Geometry	—	—	5
General Chemistry	5	5	4
English	5	5	5
Descriptive Geometry	—	2	2
Elementary Mining	2	—	—
Mineralogy	—	—	2
Qualitative Analysis	—	2	—
LABORATORY WORK:			
General Chemistry	9	—	—
Mechanical Drawing	6	6	6
Qualitative Analysis	—	9	6
Mineralogy	—	—	6
Descriptive Geometry	—	3	3
SOPHOMORE YEAR.			
LECTURES AND RECITATIONS:			
Analytical Geometry / Differential Calculus	5	—	—
Integral Calculus	—	5	—
Differential Equations	—	—	5
German, French, or Spanish	5	5	5
Elementary Mechanics	—	2	—
Advanced English	1	1	1
General Physics	—	—	5
Lithology	—	2	—
Quantitative Analysis	2	2	2
Surveying, Plane	3	—	—
Mineralogy	2	—	—
LABORATORY WORK:			
Field Practice	6	—	—
Quantitative Analysis	6	9	12
Mineralogy	6	6	—
Lithology	—	3	—
Physics	—	—	6

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
JUNIOR YEAR.			
LECTURES AND RECITATIONS:			
Assaying	2	—	—
General Geology	5	3	5
General Physics	5	—	—
Mechanics of Engineering	5	—	—
Chemical Memoirs	2	—	—
Electro-Chemistry	—	2	3
Mechanics of Materials	—	5	—
Hydraulics	—	—	5
Elements of Ore Dressing	—	—	3
Metallurgy	—	3	3
Physical Chemistry	—	2	—
Thermodynamics	—	5	—
LABORATORY WORK:			
Assaying	6	6	—
Geology	—	3	—
Field Geology	—	—	6
Physics	6	—	—
Quantitative Analysis	6	—	—
Physical Chemistry	—	3	—
Electro-Chemistry	—	3	6
Metallurgy	—	—	3
Hydraulic Problems	—	—	3
Steam	—	3	—
Excursion to Southeast Missouri.			
SENIOR YEAR.			
LECTURES AND RECITATIONS:			
Alloys	2	—	—
Alternating Current Machinery	—	5	—
Dynamo Machinery	3	—	—
Electro-Metallurgy	2	—	—
Contracts	2	—	—
Metallurgical Problems	1	—	1
Metallurgy	4	4	4
Ore Dressing	4	4	4
Compressed Air	—	2	—
Metallurgy Conference	—	1	—
Metallurgical Organization	—	3	—
Electrical Transmission	—	—	3
Memoirs, Chemical and Metallurgical	—	—	1
Hydraulic Motors and Pumps	—	—	1
Technical Chemical Analysis	—	—	1
LABORATORY WORK:			
Metallurgy and Electro-Metallurgy	6	—	—
Ore Dressing	9	—	6
Dynamo Machinery	6	—	—
Compressed Air	—	3	—
Alternating Currents	—	6	—
Metallurgy	—	7	—
Metallography	—	3	—
Electrical Problems	—	—	3
Technical Analysis (Chemical)	—	—	3
Thesis	—	—	6
Senior Trips.			

COURSE III.—CIVIL ENGINEERING.

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FRESHMAN YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	—	—
General Chemistry	5	5	4
English	5	5	5
Descriptive Geometry	—	2	2
Elementary Mining	2	—	—
Plane Trigonometry	—	5	—
Spherical Trigonometry } Analytical Geometry }	—	—	5
Mineralogy	—	—	2
LABORATORY WORK:			
General Chemistry	3	3	3
Descriptive Geometry Drawing	—	3	3
Mechanical Drawing	6	6	6
Shop Practice	6	6	—
Mineralogy	—	—	6
SOPHOMORE YEAR.			
LECTURES AND RECITATIONS:			
Analytical Geometry } Differential Calculus }	5	—	—
Integral Calculus	—	5	—
Differential Equations	—	—	5
Advanced English	1	1	1
Spanish, German, or French	5	5	5
Elementary Mechanics	—	2	—
Plane Surveying	3	—	—
Mine Surveying	—	—	3
General Physics	—	—	5
Lines of Communication	—	—	2
Geodesy	—	3	—
LABORATORY WORK:			
Field Practice	9	—	9
Forge Shop or Machine Drawing	6	6	—
Geodesy and Computations	—	9	—
Physics	—	—	6

Topography, one week.

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
JUNIOR YEAR.			
LECTURES AND RECITATIONS:			
Astronomy	—	—	2
General Geology	5	3	5
Hydraulics	—	—	5
Mechanics of Engineering	5	—	—
Masonry	—	2	—
Mechanics of Materials	—	5	—
Metallurgy of Iron and Steel	—	—	3
General Physics	5	—	—
Lines of Communication	3	—	—
Thermodynamics	—	5	—
Roads and Pavements	—	—	2
Graphics	—	2	—
LABORATORY WORK:			
Drawing and Graphics	—	—	6
Hydraulic Problems	—	—	3
General Geology	—	3	6
Field Practice	9	—	—
Engineering Laboratory and Graphics	—	12	—
Physics	6	—	—
Steam	—	3	—
SENIOR YEAR.			
LECTURES AND RECITATIONS:			
Alternating Current Machinery	—	5	—
Bridges (Higher Structures)	—	5	—
Compressed Air	—	2	—
Dynamo Machinery	3	—	—
Economic Geology	3	—	—
Electrical Transmission	—	—	3
Estimates and Bidding	—	—	2
Frame Structures	2	—	—
Hydraulic Motors and Pumps	—	—	1
Irrigation	—	—	3
Masonry Design and Concrete Steel	—	—	5
Mining Law and Contracts	2	—	—
River and Harbor Improvements	—	—	2
Railroad Economics	3	—	—
Sanitary Engineering	—	5	—
Water Supply	5	—	—
LABORATORY WORK:			
Dynamo Machinery	6	—	—
Alternating Current Machinery	—	5	—
Compressed Air	—	3	—
Designing	—	6	6
Graphics and Engineering Designs	9	—	—
Electrical Problems	—	—	3
Thesis	—	—	6

COURSE IV.—GENERAL SCIENCE.

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FRESHMAN YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	—	—
General Chemistry	5	5	4
English	5	5	5
Elementary Mining	2	—	—
German	—	4	4
Mineralogy	—	—	2
Plane Trigonometry	—	5	—
Spherical Trigonometry / Analytical Geometry	—	—	5
LABORATORY WORK:			
Drawing	6	6	6
General Chemistry	3	3	3
Mineralogy	—	—	6
Elective	6	6	—
SOPHOMORE YEAR.			
LECTURES AND RECITATIONS:			
German	5	5	5
English	5	5	5
Elementary Mechanics	—	2	—
Qualitative Analysis	—	2	—
Mineralogy	2	—	—
Elective	6	4	8
LABORATORY WORK:			
Qualitative Analysis	—	6	6
Mineralogy	6	6	—
Physics	—	—	6
Elective	9	6	3
JUNIOR YEAR.			
LECTURES AND RECITATIONS:			
French or Spanish	5	5	5
General Geology	5	3	5
General Physics	5	—	—
Elective	3	10	8
LABORATORY WORK:			
General Geology	—	3	6
General Physics	6	—	—
Elective	9	12	9

SENIOR YEAR.

All elective.

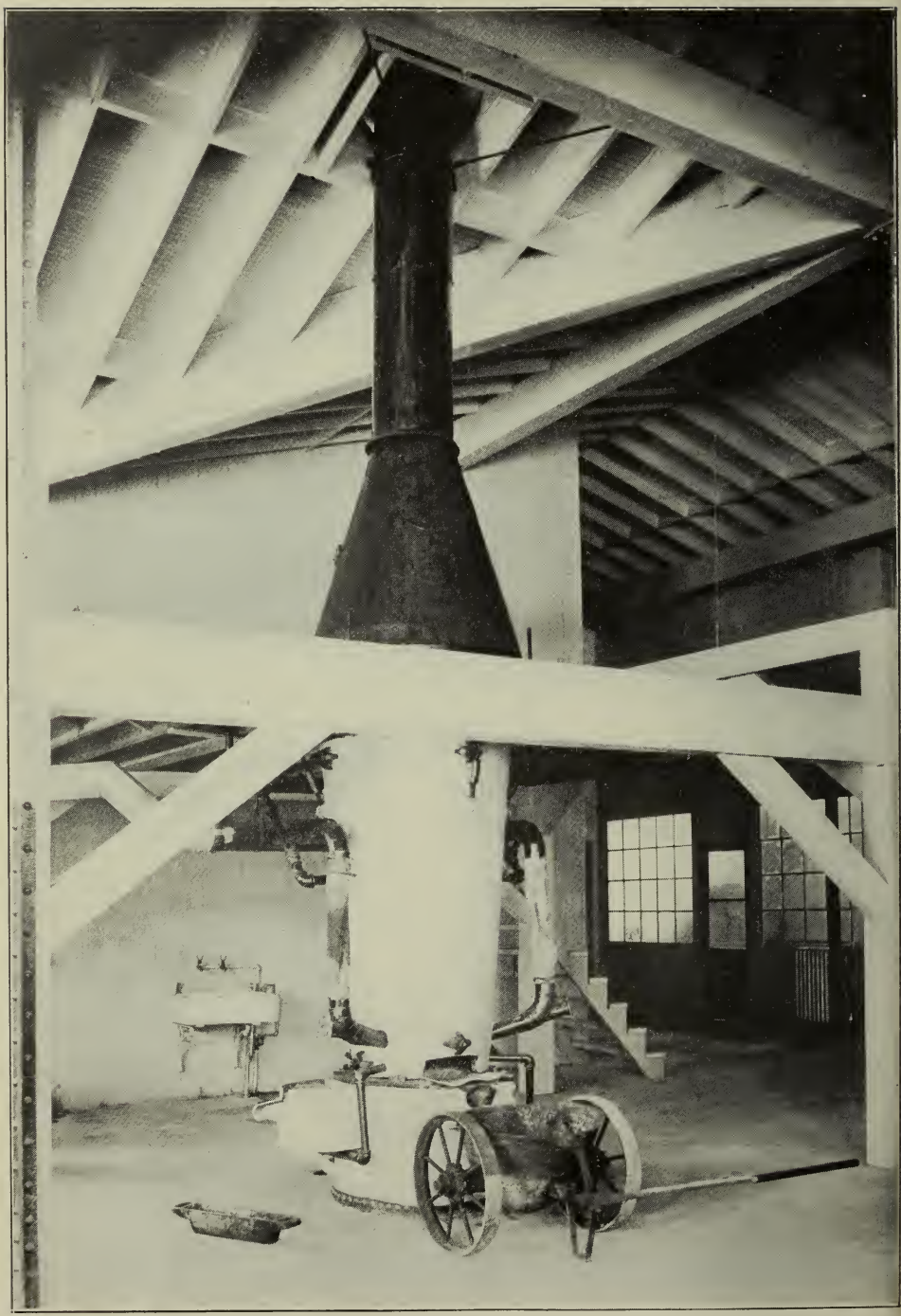
The selection of studies is subject to the approval of the Faculty.

Electives after the Sophomore year must be along one of the two lines: Physics and Mathematics, or Chemistry and Geology. Twenty-three hours recitation, or eighteen hours recitation and five afternoons laboratory work a week, constitute a course.

GRADUATE COURSE IN MINE ENGINEERING.*

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
LECTURES AND RECITATIONS:			
Mining Research	5	5	5
Mine Examination and Reports	—	3	—
Mine Plant	—	3	—
Mining Machinery	—	4	5
Mining Economics	—	—	2
Metallurgical Problems	1	—	1
Geology of the United States	3	—	—
Structural and Metamorphic Geology	—	—	3
Cement and Concrete Structures	—	—	2
Internal Combustion Engines	3	—	—
Electives	6	3	—
LABORATORY WORK:			
Mill Plant Design	—	3	9
Mining Machinery	3	9	—
Electives	9	—	—
Thesis	3	6	6

*These courses are open to students holding the degree of Bachelor of Science in Mine Engineering. The degree of Engineer of Mines will be conferred upon those who complete the course outlined.



WATER-JACKET BLAST-FURNACE

GRADUATE COURSE IN METALLURGY.*

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
LECTURES AND RECITATIONS:			
Metallurgical Research	5	5	5
Cyaniding	3	3	—
Metallurgy Plant	—	3	—
Theoretical Chemistry	2	2	2
Ore Supply	—	—	3
Geology of the United States	3	—	—
Mining Economics	—	—	2
Cement and Concrete Structures	—	—	2
Internal Combustion Engines	3	—	—
LABORATORY WORK:			
Metallurgy Plant Design	—	3	9
Cyanide Laboratory	6	6	—
Advanced Chemistry Laboratory	6	6	—
Thesis	3	6	6

*These courses are open to students holding the degree of Bachelor of Science in Metallurgy. The degree of Metallurgical Engineer will be conferred upon those who complete the course outlined.

GRADUATE COURSE FOR ENGINEERS.*

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FIRST YEAR.			
LECTURES AND RECITATIONS:			
Mine Surveying	—	—	3
Geology	5	3	5
Mineralogy	3	—	—
Lithology	—	2	—
Qualitative Analysis	—	2	—
Assaying	2	—	—
Ore Dressing	—	—	3
Mining	2	2	—
Metallurgy	—	3	3
Elective	6	6	4
LABORATORY WORK:			
Mineralogy	12	6	—
Lithology	—	3	—
Geology	—	3	6
Qualitative Analysis	—	6	6
Assaying	—	—	9
Elective	3	3	—
SECOND YEAR.			
LECTURES AND RECITATIONS:			
Compressed Air	—	2	—
Quantitative Analysis	2	—	—
Economic Geology	3	3	5
Metallurgy	4	4	4
Metallurgy Conference	—	1	—
Ore Dressing	4	3	—
Ore Dressing Memoirs	—	—	1
Mining Law and Contracts	2	—	—
Mine Management	—	—	2
Elective	3	5	5
LABORATORY WORK:			
Quantitative Analysis	6	9	—
Ore Dressing	6	—	3
Compressed Air	—	3	—
Geology	3	—	3
Metallography	—	3	—
Mining Problems	—	—	3
Thesis	—	—	6
Elective	3	3	3

*This two-year course is planned for graduates in Civil, Electrical, or Mechanical Engineering, who desire to work along mining lines. The degree, Mining Engineer, will be conferred on students who have received the Bachelor of Science Degree in Engineering, and who complete the two-year course as outlined.

MATHEMATICS.

PROFESSOR DEAN, ASSISTANT PROFESSOR GARRETT, MR. FORRESTER.

While the utility of mathematical study as a mental discipline is duly recognized, the ultimate intention of the student is kept in mind, and the matter and the method of the courses are adjusted to meet the demands of subsequent studies in pure and applied science. Daily drill in the class-room is an important feature of the work.

Students who bring credits from other colleges will be allowed to enter with advanced standing only when the courses can be shown to be equivalent to those given here, and then only conditionally. Those who fail to do creditable work in the courses undertaken will be required to drop such courses and take up more elementary work.

1. *College Algebra.*—The time allotted for this course being very short, only such work is given as is found absolutely necessary to prepare for subsequent studies.

Prerequisites: Entrance requirements.

Freshman year, first term, five hours per week.

Text: Hall and Knight, Algebra for Schools and Colleges.

2. *Plane Trigonometry.*—This subject is the most important in the mathematical equipment of the engineer. The student is drilled, not only in the solution of triangles and other geometrical problems, but in the application of the trigonometric functions to analysis and in shortening computations.

Prerequisite: College Algebra.

Freshman year, second term, five hours per week.

Text: Taylor and Puryear, *Trigonometry.*

3. *Spherical Trigonometry.*—This course is limited to practical applications in astronomy, geodesy, and mine surveying.

Prerequisite: Plane Trigonometry.

Freshman year, first two weeks of third term, five hours per week.

Text: Comstock, *Field Astronomy for Engineers.*
Taylor and Puryear, *Trigonometry.*

4. *Analytical Geometry.*—This course includes the study of the straight line, the circle, and special forms of the equations of the conic sections.

Prerequisites: Plane and Spherical Trigonometry.

Freshman year, third term after Course 3, five hours per week.

Text: Ashton, *Analytic Geometry.*

5. *Analytical Geometry.*—This is a continuation of Course 4 and includes the study of the general equation of the second degree, general theorems on conic sections, and the higher plane curves, such as the catenary, cycloid, and spirals.

Prerequisite: Course 4.

Sophomore year, first four weeks of the first term, five hours per week.

Text: Dean, *Manuscript Notes and Lectures.*

6. *Differential Calculus.*—The student is given a thorough drill in the derivation of formulae, and application of derivatives and differentials, in the solution of problems in maxima and minima, curve tracing, rates, velocities and accelerations, and expansion of functions.

Prerequisites: Courses 2 and 3.

Sophomore year, first term, five hours per week, following Course 6.

Texts: Osborn, *Calculus.*
Granville, *Calculus.*
Dean, *Manuscript Notes.*

7. *Integral Calculus.*—Attention is paid largely to attaining as much skill as possible in integration of forms occurring in mechanics and physics. As the student acquires his fund of knowledge and experience, he is drilled in evaluating areas,

lengths of curves, moments of inertia, centers of gravity, and fundamental formulae of hydraulics and hydrostatics.

Prerequisite: Course 6.

Sophomore year, second term, five hours per week.

Texts: Osborn, *Calculus.*
Granville, *Calculus.*
Dean, *Manuscript Notes.*

8. *Differential Equations.*—A continuation of Course 7, taking up more difficult problems and higher developments of the subject, dynamics of a particle, theory of attraction, and thermodynamics of perfect gases.

Prerequisite: Course 7.

Sophomore year, third term, five hours per week.

Texts: Cohen, *Differential Equations.*
Dean, *Manuscript Notes.*

9. *Mechanics of Engineering.*—It is the aim to develop the essential principles of mechanics and to train the student to be proficient in applying them to practical, rather than to theoretical, problems. A large number of problems are solved which, so far as possible, are selected from machines or structures with which the student is already familiar, or the study of which he is to take up subsequently.

Prerequisites: Courses 6 and 7.

Junior year, first term, five hours per week.

Text: Hancock, *Applied Mechanics for Engineers.*

10. *Mechanics of Materials.*—A study of the theory of stress, strain and elasticity and its application to the design of members of machines and structures; a discussion of the properties of the materials of engineering construction.

Prerequisite: Course 9.

Junior year, second term, five hours per week.

Text: Slocum and Hancock, *Strength of Materials.*

Elective Work.

Students in the General Science Course who elect work in pure mathematics will confer with the head of the department, who will arrange work according to the needs, tastes, and aptitudes of the applicants.

The following courses are offered to students who have all the required work in mathematics, mechanics, and general physics:

1. Dynamics of Particles and Rigid Bodies.
2. Hydrodynamics.
3. Mathematical Theory of Elasticity.
4. Newtonian Potential Function.
5. Harmonic Functions.
6. Theory of Least Squares.
7. Differential Equations of Mechanics and Physics.
8. Mechanics of Hoisting Machinery.

CHEMISTRY.

PROFESSOR GOTTSCHALK, ASSISTANT PROFESSOR TEST, MR. BARRETT, MR. WALKER, MR. RIEDE, MR. LANE.

Equipment.

One entire building is given to chemistry. The main chemical lecture room occupies the entire south wing of the building and contains a long lecture desk, with gas and water connections for lecture experiments, and a large glass hood and side desks fit it for demonstration purposes for large classes. The general chemical laboratories contain the lockers and desks for one hundred students.

The qualitative analysis laboratory provides desk space for forty students working at one time. A long line of hoods extends along two walls of the room. Air blast is provided and the room is well ventilated by means of a blower. The entire second floor of the building is used for quantitative analysis. The main laboratory will accommodate seventy-five students at one time. Gas and water are supplied conveniently and compressed air furnishes blast for thirteen blast lamps. The balance rooms on the north side of the building contain nineteen first-class balances.

There are several private and research laboratories on both floors.

Courses.

1. *General Chemistry.*—This course is a comprehensive study of the general principles of chemistry and of the more important elements. Special attention is paid to the chemistry of the metals. The Periodic law is followed throughout. The lectures are fully illustrated; the class is divided into several smaller sections for recitations.

Prerequisites: Entrance requirements.

Freshman year, first and second terms, five hours per week; third term, four hours per week.

Text: Kahlenberg, *Inorganic Chemistry.*

2. *General Chemistry Laboratory.*—The laboratory work accompanying general chemistry consists of experiments, which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

Prerequisites: Entrance requirements. To accompany Course 1.

Freshman year, one afternoon per week throughout the year, Civil Engineering and Mining Engineering Courses; first term, three afternoons per week, Metallurgy Course and Special Courses in Mining, Surveying, and Assaying.

Text: Ransom, and *Manuscript Notes.*

3. *Qualitative Analysis.*—This course includes lectures and laboratory work; the laboratory work includes the tests and separation of the more common metallic elements; analysis of solutions containing phosphates, of alkaline solutions, of insoluble substances, of alloys, of natural products, and of slags; also blow-pipe analysis.

Prerequisites: General Chemistry Lectures and Current Lectures and General Chemistry Laboratory.

Lectures, Sophomore year, second term, two hours per week, Mining Engineering and General Science Courses; Freshman year, second term, two hours per week, Metallurgy Course and Special Courses in Mining and Assaying.

Laboratory work, Sophomore year, second and third terms, two afternoons per week, Mining Engineering and General Science Courses; Freshman year, third term, two afternoons per week, Metallurgy Course; first year, second and third terms, three afternoons per week, Special Courses in Mining and Assaying.

The same course is given in the summer school.

Text: Tower, *Qualitative Analysis.*

4. *Quantitative Analysis.*—Introductory Course.—This work begins with a study of the balance; this is followed by accurate gravimetric analysis, first on pure soluble salts, then on natural products; then by accurate volumetric analysis (acidimetry, alkalimetry, iron by the permanganate method).

As samples of technical work, the wet assays, as practiced in the West, are studied during the latter half of the course.

Prerequisites: Courses 1, 2, and 3.

Lectures, Junior year, first term, two hours per week, Mining Engineering Course; Sophomore year, first term, two hours per week, Metallurgical Course and Special Course in Mining and Assaying.

Laboratory work, Junior year, first term, two afternoons per week; second term, three afternoons per week, Mining Engineering Course; Sophomore year, first term, two afternoons per week; second term, three afternoons per week, Metallurgy Course; second year, first term, two afternoons per week; second term, three afternoons per week, Special Courses in Mining, Chemistry, and Assaying.

The same course is given in the summer school.

Text: Miller, *Quantitative Analysis for Mining Engineers.*

5. *Quantitative Analysis Lectures.*—This lecture course comprises a complete exposition of the general methods and details of manipulation of analysis, theory of instruments used, general chemical theory not included in Freshman chemistry, and the discussion of the sources of error, including testing, purification, and preparation of reagents.

Prerequisite: Course 4.

Sophomore year, second and third terms, two hours per week, Metallurgy Course.

Text: Ostwald, *Foundations of Analytical Chemistry.*

6. *Quantitative Analysis (Advanced).*—This course is planned to train the student in general methods of technical analysis.

Prerequisite: Course 4.

Laboratory work, second year, third term, two afternoons per week, Special Course in Chemistry, Mining and Assaying.

7. *Slag Analysis.*—This course presents the methods for complete analysis of slags of various kinds.

Prerequisites: Courses 4 and 5.

Laboratory work, Sophomore year, third term, four afternoons per week, Metallurgy Course.

Text: Low, *Technical Methods of Ore Analysis.*

8. *Metallurgical Analysis.*—Advanced quantitative analysis in its application to metallurgy and metallurgical processes is presented in the laboratory.

Prerequisite: Course 7.

Laboratory work, Junior year, first term, two afternoons per week, Metallurgy Course.

9. *Technical Analysis.*—This is an advanced and applied course in quantitative analysis.

Prerequisite: Course 8.

Senior year, third term, one hour per week, Metallurgy Course.

Laboratory work, Senior year, third term, one afternoon per week, Metallurgy Course.

10. *Chemical Memoirs.*—Carefully prepared abstracts of current articles or of special subjects are prepared by the students for this course.

Prerequisites: Courses 1 to 5, 11 and 12.

Reports, Junior year, third term, three hours per week, Metallurgy Course.

11. *Electro-Chemistry.*—This course includes a theoretical introduction of the study of electro-chemistry and is followed by applications of principles.

Prerequisites: Courses 1 to 5, and 12.

Junior year, second term, four hours per week, Metallurgy Course.

Laboratory work, Junior year, second term, two afternoons per week, Metallurgy Course.

Text: Ewell's *Physical Chemistry.*

12. *Physical Chemistry.*—This is a short course, designed mainly as an introduction to the various kinds of chemical equilibria encountered in metallurgical practice.

Prerequisites: Courses 1 to 5.

Junior year, first term, two hours per week, Metallurgy Course.

Laboratory work, Junior year, first term, two afternoons per week, Metallurgy Course.

Text: Ewell's *Physical Chemistry.*

Manuscript Notes.

Graduate Courses.

13. *Theoretical Chemistry.*—The applications of theoretical chemistry to fundamental metallurgical principles are assuming such prominence and leading to such important results that a knowledge of this subject is indispensable to the metallurgical engineer who desires to keep pace with the developments in this field. To meet this demand a course for graduate students is offered, presenting the subject of chemical equilibria from the thermodynamic point of view, including a consideration of the technical applications made by Nernst, Le Chatelier, Haber, von Jueptner and others. The student is expected to do considerable reading of original articles in English, German, and French scientific journals and books.

Prerequisites: Courses 11 and 12.

Graduate Course, first and second terms, two hours per week.

14. *Advanced Physico-Chemical Laboratory.*—This is an advanced course to accompany the lectures in Theoretical Chemistry, and includes the study and measurements of typical chemical equilibria, either as a repetition of classical researches in this field, or preferably on original problems. The equipment for this work includes measuring instruments of the most approved types for high temperature, electro-thermic and physico-chemical work, and special apparatus built in the school shops.

Prerequisites: Courses 11 and 12. To accompany Course 13.

Graduate Course, first and second terms, two afternoons per week.

PHYSICS.

PROFESSOR MCRAE; MR. BRANHAM.

Equipment.

The lecture room and laboratories for Physics and Electricity are in Norwood Hall. The lecture room will seat one hundred students and is provided with water, gas, and electric connections for conveniences in lecture demonstrations and experiments.

The physical laboratory is on the ground, or basement, floor. There are two large laboratories, one equipped for general physical measurements in mechanics, sound, and heat, and one equipped for electric measurements. There is a battery room equipped with both primary and secondary batteries connected by wires with the various laboratories and the lecture room; a constant-temperature room with double walls and air space insulation; a commodious dark-room with blackened walls for spectrometric and photometric measurements, and a special laboratory for research work.

The equipment includes a Rowland electro-dynamometer with shunts and resistances; a Leeds & Northrup decade wheatstone bridge; a Queen & Co. postoffice pattern wheatstone bridge; two portable testing sets; various wheatstone bridges and resistance boxes; standards of resistance, inductance and capacity; a Lummer-Brodhun photometer; a Gaertner dividing engine, with linear and circular attachments; a Threlfall micromanometer; a Duddell thermo galvanometer; various tangent, mirror and D'Arsonval galvanometers; a Parr coal calorimeter; a wireless telegraph demonstration set; a ten-inch induction coil; Crooke's tubes; X-ray tubes; Toepler Holtz machine; a Schmidt & Haensch spectrometer; a Rowland diffraction grating; photographs of Rowland's normal solar spectrum; Crosby, and Schaeffer and Budenberg steam and gas engine indicators; Amsler planimeters; tachometers and speed counters; various balances; micrometers, calipers, together with apparatus for illustrating the principles of physics.

The dynamo laboratory contains an assortment of direct-current generators and motors, a General Electric double-current generator for direct current and alternating current work, a single and a three-phase generator, an induction motor, a rotary transformer, stationary transformers, three-phase to two-phase transformers, and a Cooper-Hewitt mercury vapor converter with testing instruments, which include a Weston laboratory standard voltmeter, with multipliers; a Weston laboratory standard milli-voltmeter, with shunts; a Kelvin electrostatic voltmeter; Weston portable direct-current ammeters; Weston portable direct-current and alternating current voltmeter; Weston and Thomson portable wattmeters; Thomson alternating-current voltmeters; Westinghouse portable polyphase wattmeter; Westinghouse portable voltmeter with transformer; Westinghouse portable ammeter with series transformer; electro-dynamometers; a Grassot fluxmeter; inductance coils, and condensers.

The power-plant also is used for experimental purposes, and comprises a strictly modern and thoroughly equipped laboratory. The machinery available for testing purposes includes three 130-h. p. Heine safety boilers. The steam engines include a 75-h. p. Ideal engine, a 35-h. p. Brownell engine, and a 7-h. p. Davis & Rankin vertical engine. A 15-h. p. Otto gas engine may be belted to electric generators or used for experimental purposes. The pneumatic equipment includes a Laidlaw-Dunn-Gordon air compressor, a Rand Imperial type air compressor, a 72-inch ventilating fan, a 36-inch ventilating fan, and a 60-inch Buffalo forge blower. There are six pumps of three different patterns, which can be used for power or experimental purposes. The electric generators include a 50-kw. Westinghouse 220-volt direct-current generator, a 3½-kw. 120-volt generator, a 7½-kw. General Electric direct and alternating-current generator, a 2-kw. three-phase Westinghouse generator, and a 1-kw. Westinghouse single-phase generator.

The various electrical motors used for power purposes in the shops and laboratories are available for testing in addition to the machinery in the dynamo laboratory. The total electrical

equipment includes thirty-five motors, varying in size from ½-h. p. to 30-h. p., with the aggregate rating of 150-h. p.

Courses.

1. *Elementary Mechanics.*—This subject includes the study of the simple machines and the fundamental principles of mechanics and hydrostatics. Lectures and recitations.

Prerequisite: Trigonometry.

Sophomores, second term, two hours per week.

Text: Merriman, *Elements of Mechanics.*

2. *Electricity and Magnetism.*—This course is designed as an introduction of the study of electricity and magnetism.

Prerequisite: Trigonometry.

Lectures and recitations, second term, three hours per week.

Text: S. P. Thompson, *Lessons in Electricity and Magnetism.*

3. *Laboratory Work in Electricity and Magnetism.*—Three afternoons per week throughout the year.

To accompany Course 2.

4a. *General Physics.*—The work in general physics begins with the study of kinematics, statics, kinetics, and the mechanics of fluids. The first term's work concludes with the study of heat, including an introduction of thermodynamics. Particular attention is paid to harmonic motion as the basis for the study of such subjects as sound, light, and alternating currents of electricity.

Prerequisite: Elementary Mechanics. To be preceded by or accompanied by Calculus.

Sophomore year, third term, five hours per week.

Text: Watson, *General Physics.*

4b. *General Physics.*—This course is a continuation of 4a and includes the study of electricity and magnetism, sound, and light. The following subjects are presented in the study of electricity and magnetism: Static electrification, potential, quantity, capacity, resistance, induction, impedance, inductive

capacity, and electric waves. During the latter part of the term the reflection, refraction, diffraction, and interference of sound and light are studied. The entire course is illustrated by lecture experiments and supplemented by work in the laboratory.

Prerequisite: Elementary Mechanics. To be preceded by or accompanied by Calculus.

Junior year, first term, five hours per week.

Text: Watson, *General Physics.*

5. *Laboratory Work in Mechanics, Sound, Light, Heat, Electricity, and Magnetism.*—In the laboratory the work is quantitative and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of relations between the quantities measured. Emphasis is laid upon the derivation of physical laws rather than the verification of them.

To accompany Courses 4a and 4b.

Sophomore year, third term, two afternoons per week; Junior year, first term, two afternoons per week.

6. *Thermodynamics.*—A short course in theoretical thermodynamics is followed by a study of boilers, furnaces, and heat engines, standard types of safety and tubular boilers, chimney and mechanical draft, pumps and heaters. Steam, gas, and gasoline engines are also studied. Recitations and lectures are supplemented by the equivalent of one afternoon per week in the steam laboratory, where practice is had in operating and indicating engines; measuring chimney draft, boiler evaporation, and the calorific value of fuels.

Prerequisite: Course 4a.

Junior year, second term, five hours per week; laboratory work, second term, one afternoon per week.

Text: Reeve, *Thermodynamics.*

7. *Dynamo Machinery.*—This course discusses the magnetic circuit of dynamos and motors, with methods of connecting for operation in series and parallel; characteristic curves, and methods of testing dynamos and motors.

Prerequisites: Courses 4b and 5.

Senior year, first term, three hours per week.

Text: Sheldon, *Dynamo Machinery.*

8. *Alternating Current Machinery.*—In this course typical single and polyphase generators, synchronous and induction motors, stationary and rotary transformers, are studied. The effect of frequency, induction, and capacity upon the impedance of circuit are presented by the graphical and analytical solution of numerous problems in transmission and distribution.

Prerequisite: Course 7.

Senior year, second term, five hours per week.

Text: Sheldon and Mason, *Alternating Current Machinery.*

9. *Electrical Transmission.*—This course includes the continuous current circuit, single and polyphase alternating current transmission, series and parallel distribution, design of the conducting system, and overhead and underground construction. Lectures and recitations supplemented by one afternoon per week in electrical problems.

Prerequisites: Courses 8 and 10.

Senior year, third term, three hours per week.

10. *Dynamo Laboratory.*—During the first term the work is in connection with the course in dynamo machinery and during the second term it is in connection with the course in alternating current machinery. The work includes the calibration of instruments, characteristic curves, efficiency tests of dynamos, motors, transformers, converters, line resistance capacity, inductance, impedance, and insulation measurements.

Prerequisites: Courses 4a, 4b, and 5. To accompany Courses 7 and 8.

Senior year, first and second terms, two afternoons per week.

Elective Courses.

11. *Theory of Electricity and Magnetism.*—In this course a mathematical treatment of electricity and magnetism is presented for graduates and advanced undergraduates.

Prerequisite: Course 4b.

First and second terms, three hours per week.

12. *Alternating Currents.*—This course supplements Course 8, and includes a rigorous analytical treatment of the subject as well as a study of various practical applications in mining and metallurgy.

Prerequisite: Course 8.

First and second terms, two hours per week.

13. *Internal Combustion Engines.*—This course includes the theory of internal combustion engines together with their practical application in mining operations and in metallurgical industries. It must be preceded by the course in thermodynamics.

Prerequisite: Course 6.

Graduate Course, first term, three hours per week.

CIVIL ENGINEERING.

PROFESSOR HARRIS, MR. MCVEY, MR. DENNIE, MR. MINOR.

Equipment.

Two large drafting rooms amply lighted and equipped for the work above the Freshman year, a blue-print room, two large lecture rooms, and a department library and study are located on the third floor of Norwood Hall.

The equipment for field practice includes thirteen transits and one theodolite, one plane table, one solar compass, one railroad compass, eleven levels, together with barometers, telemeters, chains, tapes, level rods, tools, and other necessary equipment for field practice. A number of the transits are adapted for underground surveying.

The instrument room is located on the first floor of Machinery Building and is equipped with separate lockers for the equipment of each surveying squad.

The testing laboratory is located in the basement of Norwood Hall and is equipped with suitable machinery for making tests on engineering materials.

Courses.

1. *Surveying.*—A course in general surveying, including the use of the transit, the level, and the solar compass. Students are required to plot to scale the areas surveyed and to complete the map in all its details. Following this work, city surveying and topographic methods are taught.

Prerequisite: Trigonometry and Mechanical Drawing.

Sophomore year, first term, three hours per week, Mining Engineering and Civil Engineering courses.

1a. *Field Practice.*—Students in Civil Engineering have field practice three afternoons per week during the first and third terms of the Sophomore year; the other students in surveying have field practice two afternoons per week during the first term of the Sophomore year.

To accompany Course 1.

1b. *Topography.*—The students are divided into parties, each with a captain, and to each is assigned an area to be covered. One week is given to this work in the Sophomore year. From notes so taken, the Civil Engineering students are required to produce a finished topographic map in the first term of the Junior year. Field practice only required in Mining Engineering Course.

Prerequisites: Courses 1 and 1a.

1c. *Geodesy.*—The student studies higher problems in surveying, including engineering astronomy, baseline measurements, and precise leveling.

Prerequisites: Courses 1, 1a, and 1b.

Sophomore year, second term, three hours per week, Civil Engineering Course only.

1d. *Geodesy—Computations and Drawings.*—The student is given exercises in mapping and platting, in the determination of areas, and in the partition of land. He learns to solve systematically the problems in geodesy.

To accompany Course 1c.

Sophomore year, second term, three afternoons per week, Civil Engineering Course only.

2. *Lines of Communication.*—Covers the mathematical problems in the location of railways, highways, and canals, and in setting out and estimating earthwork, laying out track, and locating tunnels.

Prerequisites: Courses 1, 1a, 1b.

Sophomore year, third term, lectures and recitations two hours per week, Civil Engineering Course; Junior year, third term, lectures and recitations two hours per week, Mining Engineering Course.

Field Practice, Sophomore year, third term, three afternoons per week, Civil Engineering Course; Junior year, third term, one afternoon per week, Mining Engineering Course.

3. *Railway Economics.*—Treats of the economic principles of railway location and improvements of old lines as affected by curvature grades, first cost, cost of maintenance, and traffic.

Prerequisite: Course 2.

Senior year, first term, two hours per week, Civil Engineering Course only.

4. *Masonry Construction.*—Treats of the economic properties of building stone, brick, and cement; the proportioning, mixing, and placing of mortars and concrete; preparation of foundations and strength and stability of masonry structures, including dams, piers, abutments, retaining walls, and arches.

Prerequisite: Mechanics of Engineering.

Junior year, second term, two hours per week, Mining Engineering and Civil Engineering Courses.

5. *Engineering Laboratory.*—Includes tests determining the strength and properties of building materials of various kinds, including stone, brick, cement, concrete, cast-iron, steel, and wood. Special attention is paid to tests of cement and cement mortar and concrete.

Prerequisite: Mechanics of Materials.

Junior year, second term, two afternoons per week, Civil Engineering Course only.

6. *Roads and Pavements.*—A discussion of the principles involved in the location and construction of highways, streets, and roads, and the merits of the various methods of paving.

Prerequisite: Course 4.

Junior year, second term, two hours per week, Civil Engineering Course only.

7. *Masonry Designs and Concrete Steel.*—Treats of the higher structures in masonry, including arches, dams, and portals, and the art and theory of concrete-steel structures. The properties, uses, and economy of cement are discussed. The student is required to prepare drawings and specifications of as many structures as possible during the time available.

Prerequisites: Courses 4 and 13.

Senior year, third term, five hours per week, Civil Engineering Course only.

8. *Hydraulics.*—Covers the theory of hydrostatics and of hydraulics; the determination of experimental co-efficients and their use as applied to the flow of water through orifices, weirs, pipes, and canals. Also the theory of hydraulic motors and dynamic pumps.

Prerequisite: Mechanics of Engineering.

Junior year, third term, five hours per week, lectures; one afternoon per week, Hydraulic Problems.

9. *Water Supply.*—Covers the selection, impounding, transporting, purification, and delivering of water supply to cities and towns.

Prerequisite: Course 8.

Senior year, first term, five hours per week, Civil Engineering Course only.

10. *Sanitary Engineering.*—Treats of the necessary precautions for the protection of water supplies from pollution and the methods available for the purification of contaminated supplies. It also includes a study of the principles involved in the collection and disposal of sewage and storm waters, and sewer construction.

Prerequisite: Course 9.

Senior year, second term, lectures and recitations five hours per week, Civil Engineering Course only.

11. *Irrigation.*—Designed to emphasize essential details of the location of canals, headworks, impounding reservoirs, and supplementary work.

Prerequisites: Courses 1, 1a, 1b, 4, and 8.

Senior year, third term, lectures and recitations three hours per week, Civil Engineering Course only.

12. *River and Harbor Improvements.*—Reviews the control of flood water, the protection of river banks, the improvement of navigation, and the protection and improvement of harbors.

Prerequisites: Courses 4 and 8.

Senior year, third term, lectures and recitations two hours per week, Civil Engineering Course only.

13. *Frame Structures.*—Designed alike for students in Mining and Civil Engineering; treats of general methods of determining stresses in such structures as single-span bridges, roof-trusses, towers, derricks, and of the design of individual members, as posts, beams, and rods to carry specified stresses.

Prerequisites: Mechanics of Materials and Course 15.

Senior year, first term, two hours per week, Mining Engineering Course and Civil Engineering Course.

14. *Bridges (Higher Structures).*—For students in Civil Engineering only and introduces the study of arches and cantilever, swing and suspension bridges.

Prerequisite: Course 13.

Senior year, second term, five hours per week.

15. *Drawing, Graphics, and Designing.*—Students in Civil Engineering are required to complete a topographic map during the Junior year. This is followed by an exercise in the elementary problems of graphic statics as applied to single-span bridges and roofs and to masonry structures.

Prerequisite: Mechanics of Engineering.

Junior year, second term, four afternoons per week, Civil Engineering Courses; Junior year, third term, two afternoons per week, Mining Engineering Course.

16. *Engineering Designs.*—A practical course in the design of steel bridges, concrete steel structures, water supplies, and sewage systems.

Prerequisite: Course 15.

Senior year, first and second terms, three afternoons per week, Civil Engineering Course only.

17. *Special Investigations (Thesis).*—In the third term of the Senior year all graduating students give two afternoons per week to original investigation in some subject which they select, with the approval of the Faculty.

18. *Compressed Air.*—Covers the laws governing the

compression, measurement, and piping of air and the application of compressed air to the industries.

Prerequisite: Thermodynamics.

Senior year, second term, lectures and recitations two hours per week; laboratory, Senior year, second term, one afternoon per week, Mining Engineering and Civil Engineering Courses.

19. *Astronomy.*—A course in general astronomy is given for students in Civil Engineering.

Prerequisites: Courses 1c and 1d.

Junior year, third term, two hours per week.

20. *Hydraulic Motors and Pumps.*—Problems on hydraulic motors and dynamic pumps.

Prerequisite: Course 8.

Senior year, third term, one hour per week, Mining Engineering and Civil Engineering Courses.

MINING ENGINEERING.

DIRECTOR YOUNG AND PROFESSOR FORBES.

The School of Mines and Metallurgy offers a regular four-year course in Mining Engineering. At the beginning of the Senior year three options are offered in place of the Senior course of study in the regular Mining Engineering Course.

Equipment.

The surveying equipment already referred to in Civil Engineering is used for mine surveying. The School of Mines has several thousand drawings and blue-prints of mining machinery and mine plants which are used in connection with work in mining and mine management. There are also in the Library a large number of lantern slides and photographs illustrating mining practice in the United States.

The laboratories contain air-compressors, pumps, rock-drills, special drill-steel, and models of mine timbering, which are used for demonstration and experimental work.

Courses.

1. *Elementary Mining.*—This short course outlines the principles on which the science of Mining Engineering is founded, and is designed to introduce the student to fundamentals which will enable him to appreciate the applications of the other studies of the Freshman and Sophomore years.

Prerequisites: Entrance requirements.

Freshman year, first term, two hours per week.

2. *Mining.*—This course includes lectures on prospecting, drilling, blasting, boring, tunneling, shaft sinking, and mining methods. The various tools and appliances used in these operations are described. A review of methods of mine timbering is included in the course.

Prerequisite: Course 1.

Sophomore year, first term, two hours per week, Mining Engineering Course.

The same course is given in the summer school.

3. *Mining.*—This course is a continuation of Course 3 and includes lectures in mine haulage, hoisting, mine drainage, mine ventilation, lighting, accidents, and hygiene.

Prerequisite: Course 2.

Sophomore year, second term, two hours per week, Mining Engineering Course.

4. *Mine Surveying.*—The theory and the practice of the surveying of mineral lands and mines are presented by lectures. Many problems are introduced and the student is trained in various calculations, including the reduction of notes of underground surveys requiring the auxiliary telescope, volumes of stopes, mineral acreage, intersections of veins, underground connections, and general problems in the determination of the location of mine openings. A mine surveying trip to the Joplin district is a required part of the work of the Junior year.

Prerequisite: Plane Surveying.

Sophomore year, third term, three hours per week, Mining Engineering Course.

5. *Junior Trip.*—At the end of the school year the members of the Junior class make a three weeks' trip to the mining districts of southeast and southwest Missouri. The purpose of the trip is to give an opportunity for the study of the methods of mining and the concentration of ores in the districts visited, together with work in mine surveying and geology.

A complete report of the work of the trip is required.

Prerequisite: General Geology, Elements of Ore Dressing, Mining Courses 1, 2, 3, and 4.

6. *Mining Law and Contracts.*—The general principles of mining law are reviewed with discussions of legal decisions in representative cases. The students are given the general principles governing the making of contracts, together with discussions of contracts typical of various mining districts.

Senior year, first term, two hours per week, Mining Engineering, Civil Engineering, and Metallurgy Courses.

7. *Mine Management.*—This course is planned to give the student an idea of the principles of management of mining enterprises, and reviews methods of mine organization, mine accounting, and presents economic problems in connection with mine management. The practice of mine examination and mine reporting is reviewed.

Prerequisites: Courses 1 to 6.

Senior year, third term, two hours per week, Mining Engineering Course.

Texts: Rickard, *Economics of Mining.*
Rickard, *Ore Sampling.*

8. *Mining Machinery Laboratory.*—Prior to undertaking laboratory work on special mining machinery, the student is given a thorough training in the machine shop. This work includes chipping to a line, filing to a dimension, and scraping to a surface plate; the principles and uses of the drill-press, planer, lathe, shaper, and milling machine. In this work use is made of the vernier micrometer, thread micrometer, and gear-tooth caliper. The degree of accuracy thus acquired enables the student to use eye and hand in unison and is of lasting benefit in teaching exactness in statement and measurement.

Special attention is given to various types of mining machinery and to the study of steel and other materials which enter into the construction of such machinery.

Prerequisites: Courses 2 and 3.

Laboratory work, Senior year, first term, one afternoon per week; second term, three afternoons per week, Mining Machinery Option.

9. *Mining Machinery.*—This course includes an outline of the various types of machinery used in mining operations and is planned to familiarize the student with the best designs of machinery in order that he may be able to select the proper machine for the particular condition; that he may know when each machine operates efficiently, and know how to keep the machine in a first-class condition.

The machinery studied includes rock-drills, coal-cutters, mine-hoists, mine-pumps, mine-locomotives, wire-rope haulage systems, mine-fans, excavating machinery, and safety appliances.

Prerequisites: Courses 2, 3, and 7.

Senior year, second term, four hours per week; third term, five hours per week, Mining Machinery Option.

10. *Mining Machinery Problems.*—This course is a continuation of Course 8, and includes advanced work in the machine shop in connection with mining machinery. The methods of testing various machines under working conditions are presented and whenever possible such tests are carefully carried out underground.

Prerequisites: Courses 8 and 9.

Senior year, third term, two afternoons per week, Mining Machinery Option.

Graduate Courses.

11. *Mine Examination and Reports.*—This course reviews the various types of reports which a mining engineer may be required to make and emphasizes particularly the form and style of the report. Reports prepared by representative engineers are studied. Methods of mine sampling and mine valuation are reviewed. Each student prepares several reports and studies the best means of illustrating and presenting technical reports.

Prerequisites: Courses 6 and 7.

Graduate Course, second term, three hours a week.

12. *Mine Plant.*—The complete mine plant is studied. Both metal and coal mine equipment are considered and each student is assigned, for special study, one of the plants visited on the Junior trip. The course reviews the design and construction of mine buildings, ore-bins, head frames, power plants, and mining machinery plants. The financial problems involved are considered in a thorough manner.

Prerequisites: Courses 2 and 3.

Graduate Course, second term, three hours a week.

13. *Mine Plant Design.*—This course supplements the lecture course in Mine Plant. Each student is required to prepare complete drawings for the equipment of a given mine. Bills of materials, specifications, and complete estimates are submitted.

Prerequisites: Frame Structures and Courses 2 and 3.

Graduate Course, second term, one afternoon a week; third term, three afternoons a week.

14. *Mining Economics.*—Various economic problems of interest to mining engineers are studied. The influence of mining in the history of America and especially in United States history is reviewed and the relation of mining to other industries is considered. The organization of the mining industry, the conservation of the mineral resources, and various problems in economics, including mining labor, wages, capital, taxation, profit-sharing, and employers' liability are presented by lectures and assigned reading.

Prerequisites: Economic Geology and Courses 6, 7, and 11.

Graduate Course, third term, two hours a week.

15. *Mining Research.*—Each student is permitted to elect a subject for special study. It is recommended that this subject shall be along a line different from the thesis. The work begun in the fall term is continued throughout the year and consists of conferences with the professor, assigned reading, and research.

Graduate Course, five hours a week throughout the year.

GEOLOGY AND MINERALOGY.

PROFESSOR GRISWOLD, ASSISTANT PROFESSOR COX, MR. MCNUTT.

Equipment.

The mineralogy laboratories are on the second floor of Norwood Hall. They are equipped with suitable tables for the examination of minerals and rocks. They contain the extensive collections of wooden and glass models and the reference and working mineral collections. The laboratory for lithology contains a representative collection of rocks for reference and a large working collection.

The geological and mineralogical equipment includes a representative collection of minerals, rocks, and fossils for class use; a large collection of cabinet specimens of minerals and ores, and of materials illustrating metallurgical processes. There have been recently added to the equipment of this department several large geological relief models, which aid materially in the work in stratigraphical structural geology.

There is also a collection of thirty-five hundred specimens, representing the mineral wealth of Missouri, consisting of coal, clays of many sorts, and building stones, and ores of lead, zinc, iron, and copper. The minerals occurring as gangue with the metalliferous deposits of the State are also well represented. There is also a complete collection of the economic minerals of Missouri and a good economic geological collection representing the world at large. This collection was a part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago. It was presented to the School of Mines and Metallurgy by the General Assembly in 1895.

In addition to the above mentioned collection, the State Board of Equalization assigned to the School the specimens, models, maps, and machinery which constituted the Missouri Mining Exhibit at the St. Louis Exposition, thus giving to the School a large amount of valuable equipment.

The Museums contain crystals and minerals from various important mining districts of the State of Missouri, the eco-

nomic collections from southwest Missouri, the great geological relief map from the St. Louis Exposition, polished stone tables and other complete collections of the Missouri Building and ornamental stones from the same exposition.

A rock section machine and instruments for geological surveys are included in the equipment of this department.

Courses.

1. *Mineralogy* (*Crystallography*).—Open to all. A study of the crystal systems, illustrated by wooden and glass models and actual crystals.

Lectures, Freshman year, third term, two hours per week.

Laboratory work, Freshman year, third term, two afternoons per week.

Text: Dana, *Text-book of Mineralogy.*

2. *Mineralogy* (*Physical Properties of Minerals*).—Open to those who have completed crystallography and Freshman chemistry. The course of lectures and laboratory work which are carried on alternately. The work includes the description, study, and identification of 200 minerals, special care being given to those minerals which constitute ores (both metallic and non-metallic), gangue materials, and the principal rock-forming silicates.

Lectures, Sophomore year, first term, two hours per week.

Laboratory work, Sophomore year, first and second terms, two afternoons per week.

The work of the first two terms is repeated during the summer school.

3. *Lithology.*—Open to those who are taking mineralogy. The course consists of the study of igneous, sedimentary and metamorphic rocks by the aid of a pocket lens. The well crystallized igneous rocks are studied with reference to their texture, mineral composition, and acidity as indicated by their general appearance; while those which are fine grained or glassy, together with the sedimentary and metamorphic rocks, are studied with respect to their general appearance and struc-

ture. This course is adequate for all general field determinations.

Lectures, Sophomore year, second term, two hours per week.

Laboratory work, Sophomore year, second term, two afternoons per week.

Text: Kemp, *Handbook on Rocks.*

4. *Petrography (Mining Geology Option Course).*—Open to those who have completed mineralogy and lithology. The first term is devoted to the study of optics as applied to the examination of minerals by the polarizing microscope and the identification of the rock-forming minerals. The second term includes the study of rock nomenclature and the grinding of rock and mineral thin sections. The third term consists of the complete description of rocks from both hand specimen and thin section, and a study of rock alterations.

Lectures, Senior year, first, second, and third terms, three hours per week.

Laboratory work, Senior year, first term, three afternoons per week; second and third terms, two afternoons per week.

Texts: Luquer, *Minerals in Rock Sections.*
Kemp, *Handbook of Rocks.*
Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*

5. *General Geology.*—This is a lecture course involving the principles of general and economic geology. It discusses the evolution of the earth, its present condition, and the processes which have modified its crust and surface.

Junior year, first term, five hours per week; second term, three hours per week; third term, five hours per week.

Prerequisites: Courses 2 and 3.

Text: Scott, *An Introduction to General Geology.*

6. *General Geology Laboratory—Structural Geology.*—The student has work upon geological models, maps, and

photographs, with the view to interpreting geological structures and land surface forms.

Prerequisite: General Geology, first term.

Junior year, second term, one afternoon per week.

Field Work.—The student visits various localities near Rolla with the instructor and has the various types of geology explained; then he is assigned an area to map geologically.

Junior year, third term, two afternoons per week.

The course is supplemented by the summer field excursions to southeast Missouri or Colorado.

7. *Economic Geology.*—This is a series of lectures dealing with the occurrence, origin, and distribution of ores, clays, building stones, gems, water supply, and other products of economic value from the different geological formations. The characteristics and genesis of ore deposits are carefully considered. The members of this class visit local points of economic importance near Rolla, studying iron, lead, coal, clay, and building-stone, besides making an excursion to the zinc-lead district of Joplin.

Prerequisites: Courses 5 and 6.

Senior year, first and second terms, three hours per week; third term, five hours per week.

Text: Ries, *Economic Geology of the United States.*

8. *Geology of the United States.*—This lecture course considers the various geologic and physiographic provinces of the United States and adjacent areas in the relation to geological development and economic interest.

Prerequisite: Course 5.

Optional for Seniors, first term, three hours per week.

9. *Geological Conference.*—The conference consists of a discussion by the students and instructors of geological literature or problems associated with extra reading or with the laboratory work of the term.

Prerequisite: Course 5.

Optional for Seniors, second term, two hours per week.

10. *Structural Geology.*—Open to those who have completed general geology. The course consists of a study of rock deformations, the evidence of and the resulting structures, and includes a review of the theories of the origin of the earth, a discussion of the zones of rock fracture, rock flowage, and combined rock fracture and flowage; and a classification and discussion of cleavage, joints, faults, folds, autoclastic rocks, conglomerates and pseudo-conglomerates, and mountain building forces, together with the horizontal and vertical depths affected, with applications to special districts.

Lectures, three hours a week, third term.

11. *Senior Geological Laboratory.*—(a) One afternoon per week is given to mapping a local area, the resulting map to be accompanied by a geological report.

Prerequisites: Courses 5 and 6.

Senior year, first term, Mining Engineering Course.

(b) This includes the drawing of maps and sections; or experimental work, planned with reference to the Geological Conference (Course 9) and to Structural Geology (Course 10).

Senior year, second term, two afternoons per week.

(c) Excursions are made to various localities of economic interest within easy reach of Rolla, and also to the Joplin district.

Senior year, third term, one afternoon per week, Mining Engineering Course; optional for Seniors, third term, one afternoon per week.

METALLURGY AND ORE DRESSING.

PROFESSOR COPELAND, MR. DUDLEY, MR. MANN, MR. HARLAN.

Equipment.

The assay laboratory has a floor space of forty-eight hundred square feet. In the main room are twenty coal-fired double-muffle assay furnaces, twelve gasoline-fired muffle furnaces, and ten coke-fired furnaces. Desks containing lockers, pulp balances, and fluxes are arranged close to the furnaces.

A room 16 by 16 feet, separated from the furnace laboratory by glass partitions, is used for parting. There are in this room the necessary hot plates, acid jars, and annealing muffles. The desks in this laboratory are topped with white tiling.

The balance room is 20 by 20 feet and is lighted only from the north. It is easily kept at constant temperature. There are eleven balances suitable for weighing gold. A number of these balances have the multiple-rider attachment.

For chemical work in connection with metallurgy, there is a well-lighted room having fifty-six lockers and fifty-six desks. Each desk is provided with gas, compressed air, and water. There is in the room ample hood space; in fact, the laboratory has everything necessary for general chemical work.

There is in the main furnace room a circular water-jacket blast furnace, 20 inches in diameter at the tuyeres, and 7-foot smelting column. This furnace is used for lead and copper smelting. For roasting ores a hand reverberatory furnace, with a hearth 4½ by 9 feet, is provided. This laboratory contains also an experimental pot roaster, an experimental zinc distilling furnace, 3 Le Chatlier thermo-electric pyrometers, a Wänner optical pyrometer, a cyanide testing plant containing tanks capable of holding 100 pounds of ore, a laboratory tube-mill, and laboratory amalgamating pans.

A stock room, containing chemicals, clay goods, glassware, and other supplies, serves all the laboratories. The ore-sample room is especially well equipped. It contains more than 1,000 samples of ore of varied classes. Each sample is stored away in paper sacks, all ready for issuing to the students. Each

COAL FIRED ASSAY FURNACES

sample has been prepared and carefully assayed. Enough of each lot of ore has been prepared to give 200 to 300 samples of the same lot. The sample room, therefore, contains more than 1,000 different samples of ore, each sample being divided into 200 or more smaller samples, each of the smaller samples being ready for immediate issue.

Throughout the metallurgical and ore-dressing laboratories care has been taken that each furnace, each piece of apparatus, should be so arranged as to be fitted best for that testing work which must be so great a part of the students' work. In all the laboratory work, in addition to demonstrating the theories and principles explained in the class room, the attempt is made to give the man ability to do a day's work and to teach him to use both his head and his hands.

The main floor of the new ore-dressing laboratory occupies a space of forty-eight hundred square feet and a mezzanine floor provides an additional space of thirteen hundred square feet. The equipment of the laboratory is as follows: The crushing and sampling department contains a gyratory breaker, a Dodge breaker, a pair of 9-in. by 12-in. rolls, two plane shaking screens, two Vezin samplers, two bucket elevators, three belt conveyors, and six ore storage bins, each equipped with an automatic feeder. For fine crushing and amalgamation tests are provided a three-stamp mill, with amalgamated plates, and a 3½-ft. Huntington mill.

Ores are prepared for concentration by the following series of machines: Three trommel screens, a duplex Callow traveling belt screen, a Richards pulsator classifier, a four-spigot Richards vortex classifier, a three-spigot cone classifier, a small Tamarack classifier, and four Callow settling cones.

Methods of concentrating coarsely-crushed ores are illustrated by three five-cell differential motion Harz jigs, a Richards pulsator jig, and a small model of the Hancock jig. Sands are treated on two laboratory-size Wilfley tables, one laboratory Card table, and one laboratory James table. A four-foot Frue vanner and a five-foot Sperry slimer are provided for the treatment of fine materials.

Two direct-connected motor-driven centrifugal sand pumps are used for elevating finely crushed ore to the screening and classification system.

The sample finishing room contains a small Blake crusher, a disc grinder, a coffee mill, a pair of rolls, a number of bucking boards and mullers, and an electric sample dryer.

The cyanide unit contains a laboratory leaching plant with all necessary tanks, a 16-in. Hendryx clay agitator, a 14-in. Hendryx combination agitator and filter, and a six-leaf 12-in. by 12-in. filter press.

Ores suited to magnetic concentration are treated on a Knowles magnetic separator, and for the preparation of such ores a cylindrical dryer and roaster, together with a plane impact screen for dry sizing, is provided.

Throughout the mill, wherever possible, the practice of driving each machine with an individual motor has been followed.

Courses.

It is recognized that a school cannot give students, in the brief time at its disposal, that skill which comes from long practice, but it is the aim to give such training in the fundamental principles and their application, that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems.

An important feature of the instruction is experimental investigation in the metallurgical treatment of various ores.

1. *Fire Assaying.*—This work includes the assay, by scorification and crucible methods, of ores from the various mining districts of the United States. Copper ores, copper mattes, and copper bullions are assayed by fire and by the combination method. Lead ores and furnace products are assayed for lead and for gold and silver. Assays of cyanide solutions, of zinc-box residues, of silver bullion, of gold bullion, of lead bullion, and of silver-mill precipitate, are included in this course. During the course the student has practice with coal furnaces, coke furnaces, and gasoline furnaces. Besides doing the ordinary

work of assaying, the student studies the losses occurring. He learns the effects of different schemes of firing the furnaces by making analyses of the flue gases and by pyrometric measurements. The laboratory is so aranged that even with large classes a student is not hampered by other students and he learns to handle a large amount of work with the best utilization of his time.

The laboratory course is supplemented by lectures.

The same course is given in the summer school.

Prerequisites: General Chemistry and Laboratory. To be preceded or accompanied by Mineralogy.

Text: Lodge, *Notes on Assaying.*

Fulton, *Assaying.*

2. *General Metallurgy and Metallurgy of Iron.*—This course begins with general principles, including properties of metals and alloys, fuels, fluxes, calculation of charges, general study and classification of furnaces, followed by a study of processes employed for the production of cast iron, wrought iron and steel.

Prerequisites: Qualitative Analysis, Mineralogy, and Assaying Lectures.

Junior year, second and third terms, three hours per week.

Text: Campbell, *Manufacture and Properties of Iron and Steel.*

Stoughton, *Iron and Steel.*

References: Roberts-Austin, *Introduction.*

Howe, *Metallurgy of Steel.*

3. *Metallurgy of Lead and Silver.*—The properties and uses of lead, and of its alloys and compounds, are discussed in this course. A study is made of the principles and practice of sampling and purchasing ores. The major part of the course is given to the consideration of the standard and proposed methods for winning, desilverizing, and refining lead. Great stress is laid on the principles involved, and the student is referred to the text and to current literature for the details of processes. The winning of silver by smelting, amalgamation, and leaching is studied. Especial attention is given to cyanid-

ing of silver ores. Throughout the course there is brought forward the commercial view-point as well as the views strictly technical.

Prerequisites: General Metallurgy and Qualitative Analysis.

Senior year, first term, four hours per week.

Texts: Hofman, *Metallurgy of lead.*
Collins, *Metallurgy of Silver.*

4. *Metallurgy of Copper, Nickel, Mercury, Tin, Antimony.*—The metallurgy of copper is the principal part of the course. The lectures deal with the properties and uses of the copper and copper products and with the principles employed in the winning and refining of copper. Inasmuch as the metallurgy of copper is continually changing it is necessary for the student to examine carefully the various technical journals and to note the improvements and also the varying conditions affecting the metallurgy of copper.

The metallurgy of nickel, mercury, tin, and antimony are discussed only briefly.

Prerequisites: Course 2 and Quantitative Analysis.

Senior year, second term, four hours per week.

Text: Peters, *Principles of Copper Smelting.*

5. *Metallurgy of Gold and Zinc.*—The course of the metallurgy of gold considers the extraction of gold by the standard methods. Especial attention is given to cyaniding. The rapid advances in cyanide practice are discussed in the class room, and laboratory experiments on debated points are encouraged.

The course in the metallurgy of zinc includes lectures on the properties of zinc and its compounds, the concentration of zinc ores, and the manufacture of spelter and of zinc paints.

Prerequisites: Course 2 and Quantitative Analysis.

Senior year, third term, two hours per week.

Texts: Rose, *Metallurgy of Gold.*
Ingalls, *Metallurgy of Zinc.*

6. *Constitution of Alloys.*—These lectures deal with the

theoretical and practical considerations that influence the structure and properties of alloys of different types.

Prerequisite: Course 2.

Senior year, first term, two hours per week, Metallurgy Course.

7. *Electro-Metallurgy.*—Lectures are given covering the electro-metallurgical processes that are in use. Efficiency and engineering calculations based on these processes are given.

Prerequisites: General Physics, Electro-Chemistry, Physical Chemistry, and Course 2.

Senior year, first term, two hours per week, Metallurgy Course.

8. *Metallurgical Organization.*—The course briefly takes up the principles of organization and the duties of officers and accounting force of a metallurgy plant. The outline shows the extent of the course. Organization of companies and working forces, management, superintendence, skilled and unskilled labor. Then, following this, the constitution of capital, stocks, bonds, dividends, and profits.

Prerequisite: Course 3.

Senior year, second term, three hours per week, Metallurgy Course.

Text: Conyngton, *Corporate Management.*

9. *Metallurgical Problems.*—These problems aim to cover the common ones that the metallurgist meets in practice.

To accompany Courses 3 and 5.

Senior year, first and third terms, one hour per week, Metallurgy Course.

Text: Richards, *Metallurgical Problems.*

10. *Memoirs.*—The student in the Metallurgy Course is required to do a considerable amount of technical reading in German and English. Carefully prepared abstracts of valuable current articles are presented and read by the students themselves. These articles are chosen by reason of having special value along chemical or metallurgical lines.

Prerequisite: Course 4.

Reports, Senior year, first term, one hour per week, Metallurgy Course.

11. *Metallurgical Laboratory.*—This course aims to familiarize the student with the use of calorimeters and pyrometers and their calibration. Some insight is given into the ordinary methods of metallurgical investigation, and the methods of measurement which a metallurgist should know how to conduct.

Prerequisites: Courses 1 and 2.

Junior year, third term, one afternoon per week, Metallurgy Course.

Text: Howe, *Laboratory Notes.*

12. *Metallurgy Conference.*—This work is of great value to the student and aids him materially in getting the full value of his laboratory work.

To accompany Course 13.

Senior year, second term, one hour per week.

13. *Metallurgical Laboratory.*—This course covers the testing of ores for process of treatment. Ores are tested by cyaniding, chlorination, amalgamation, lixivation, concentration, and by combination methods. With aid of smelter schedules, the smelting costs are calculated and the net dollars and cents returns are balanced against the best results by any method, or combination of methods, worked out in the laboratory. The endeavor is made, not only to teach metallurgical principles in the laboratory, but also to bring home to the student the great effect which freight rates and other factors might have on the treatment which an ore should receive. Experiments are made in the reverberatory and "pot" roasting of ores, and on blast-furnace smelting of ores.

Furnace heat-equations are made by each student from data collected by himself.

The same course is given in the summer school.

Prerequisites: Courses 1 and 3.

Senior year, second term, one afternoon per week.

Text: Howe, *Laboratory Notes.*

14. *Metallography.*—This is a study of the micro-structure of iron and steel and of the effects of heat treatment.

Prerequisites: Courses 2 and 6.

Senior year, second term, one afternoon per week, Mining Engineering and Metallurgy Courses.

15. *Metallurgical Problems.*—This course has reference to the designing and proportioning of various types of furnaces for special duties and conditions. It necessitates a clear conception of metallurgical principles.

The alternative, electro-metallurgical problems, will cover the design and estimates for a copper or copper-nickel refinery.

Prerequisite: Course 4.

16. *Electro-Metallurgy Laboratory.*—This course gives a study of the principles of electro-metallurgy from the standpoint of experiments actually performed. Tests are made on the electrolytic refining of copper and of lead bullion. Experiments are performed and calculations as to efficiency are made on electric smelting.

Prerequisites: Electro-Chemistry Lectures and Laboratory and Physical Chemistry Lectures and Laboratory. To accompany Course 7.

Senior year, first term, two afternoons per week, Metallurgy Course.

17. *Metallurgy Plant.*—The arrangements of various metallurgical works are studied. The advantages and disadvantages of different equipments are given. Throughout the entire course stress is laid on the financial problems.

Prerequisite: Course 5. To accompany Course 18.

Graduate course, second term, three hours per week.

18. *Metallurgy Plant Design.*—This is a drafting-room course, and the student is given problems to solve in detail, covering a part of the class room discussions. Each student is required to submit complete drawings, specifications, and estimations of cost.

Prerequisite: Mechanical Drawing. To accompany Course 17.

Graduate course, second term, three hours a week; third term, nine hours a week.

19. *Cyaniding.*—This course teaches the principles and practice of cyaniding. The student keeps up with the progress in the art. Attention is given in all the work to the cost of operation and to the schemes used and proposed for lessening the cost. A detailed study is made of the types of filter presses, crushing machinery, and other devices used in cyanide mills. Cyaniding is compared with other possible methods of treatment.

Prerequisite: Quantitative Analysis. To accompany Course 20.

Graduate course, first and second terms, three hours a week.

20. *Cyanide Laboratory.*—The student in this course has an opportunity to test in the laboratory the methods discussed in the class room. The work is not routine, but the experiments are arranged to bring out a point under discussion or to solve, if possible, the problems occurring at the time in the class room.

Prerequisite: Course 1. To accompany Course 19.

Graduate course, first and second terms, six hours a week.

21. *Ore Supply.*—This course is intended to bring out the important subject of ore, flux, and fuel supplies. The subject is studied from a combined commercial and technical standpoint. The problems of valuing fluxes and fuels, of mixing ores so that the mixture shall command the lowest treatment rate, and of preparing, from the reduction works standpoint, treatment charges for different classes of ores, are studied.

Prerequisite: Course 5.

Graduate course, third term, three hours a week.

22. *Metallurgical Research.*—Each graduate student elects a subject for special study. It is recommended that the work

ORE DRESSING BUILDING

be along a different line from the subject chosen for thesis. The course consists principally of assigned reading, together with conferences with the professor on the matter read. The laboratories are always open for the solving of any problem that may arise.

Prerequisite: Course 5.

Graduate course, five hours a week throughout the year.

23. *Elements of Ore Dressing.*—In this course the principles of all common ore-dressing processes are briefly discussed. The various machines used for crushing, classification, and concentration of ores are described. Especial attention is given to those processes and mill schemes which the student has opportunity to see while on the Junior trip.

Prerequisite: Elementary Mechanics and Mineralogy.

Junior year, third term, three hours per week.

Text: Richards, *Text-Book of Ore Dressing.*

24. *Ore Dressing.*—In this course the principles of mechanical ore treatment are discussed in detail. The construction and theory of machines are presented in lectures, supplemented by a full equipment of models, which show the design of all common ore-dressing appliances.

The latter part of the course deals with the management of mills and with the adaptation of processes to the successful treatment of various ores.

Prerequisite: Course 23.

Senior year, four hours per week, throughout the year.

Text: Richards, *Text-Book of Ore Dressing.*

25. *Ore Dressing Memoirs.*—The student is required to do considerable reading and to prepare abstracts of articles appearing in the current technical literature. Articles of special interest in ore dressing are assigned for discussion at the weekly conference.

To accompany Course 24.

Conference, Senior year, third term, one hour per week.

26. *Ore Dressing Laboratory.*—The student becomes familiar with the operation and care of milling machinery by actual laboratory experience. All types and classes of machines are available to illustrate principles and practice as presented in the lecture work. The laboratory is so arranged that a number of mill schemes may be utilized and processes for treating a particular ore can be determined from mill tests on large quantities of the ore.

Prerequisites: Courses 1 and 23, and Quantitative Analysis. To accompany Course 24.

Senior year, first term, two afternoons per week.

27. *Ore Dressing Laboratory.*—This course is more extensive than Course 5. Besides the regular mill practice, the student makes sizing tests upon the products of breakers and determines the quality of work done by concentrating machines under varying conditions. Each student is assigned independent experimental work involving the theoretical principles which are of importance in ore dressing.

Prerequisites: Courses 1 and 23, and Quantitative Analysis. To accompany Course 24.

Senior year, first term, three afternoons per week; third term, two afternoons per week, Metallurgy Course and Ore Dressing Option Course.

28. *Ore Dressing Problems.*—In this course advanced work is given in connection with the design of plants and machinery for the treatment of ores. The course includes the determination of a practical process for treating a given ore, and the design of a mill for utilizing this process.

Prerequisite: Course 26 and Mechanical Drawing. To accompany Course 24.

Drafting room and laboratory work, Senior year, second and third terms, one afternoon per week.

WOOD SHOP

SHOP PRACTICE AND DRAWING.

Assistant Professor Bowen, Mr. Buerstatte.

Equipment.

The shops are thoroughly equipped with machinery and benches adapted to instruction. The wood bench work-room contains twenty double benches with separate sets of hand tools. The lathe-room is equipped with twenty Fay & Egan 12-in. swing college wood lathes and iron shears. The other machines in the lathe-room include a Fay & Egan 27-in. planer, a Fay & Egan bandsaw with 30-in. wheels, an Oliver universal saw-table, two Oliver wood trimmers, a mortise machine, jig-saw, grindstone, and other necessary tools.

For instruction in forge work there are twenty-four Buffalo Forge Company down-draft forges, power hammer, drill-press, power shears, and grinder.

The metal-working room contains:
One 20-in. by 8-ft. Reed Lathe.
One 12-in. by 6-ft. Reed Lathe.
One 14-in. by 6 ft. Hendey Lathe.
One 14-in. by 6-ft. American Lathe.
One No. 2A Brown & Sharpe Universal Milling Machine.
One Hendey 15-in. Pillar Shaper.
One Dwight Sensitive Drill.
One Barnes 22-in. Swing Upright Drill Press.
One 24-in. Morse Double Emery Grinder.
One 24-in. by 24-in. by 6-ft. Chandler Planer.
Two Greenard Arbor Presses, No. 3½ and No. 1.
One No. 1 Burr Cold Saw.
One 3-fire Chicago Flexible Shaft Gas Furnace.

All of the above mentioned iron-working machinery is of latest design and driven by individual motors. The benches in the lathe-room have hardwood tops mounted on standard Brown & Sharpe bench legs. Twenty-four machinist vises, twelve of which have the swivel base and jaw, equip the shop for bench work.

The drawing rooms are equipped with double drawing tables and will accommodate two hundred and forty students working in two sections.

Courses.

1. *Wood Work.*—The work in this course begins with simple exercises in planing and marking with the gauge and knife. It continues until the pupil has become thoroughly familiar with the use of the plane, bevel, square, gauge, and knife. He is then given graded exercises covering rip and cross-cut sawing and sawing to a "fit." Following this comes work at joints designed to show the different methods of construction, glue joints, doweling, dove-tails, and braces. This work is supplemented by talks on the tools and work in hand, and each student is required to pass a written examination on notes covering the classification and use of hand tools and accessories.

This preliminary work is followed by the construction of a drawing desk of our own design, which is a very rigid and substantial individual desk. It is designed for two sections, each student having a separate drawer and locker for instruments and drawing board, where they are free from disturbance and dust. Following the desk comes wood turning, which is designed to familiarize the student with the use of the lathe. He is given graded exercises, beginning with a plane cylinder, including curves of various kinds and sizes and concluding with face-plate work in rings, balls, goblets, and vases. On all the preliminary work students are required to use the tools in such a way as to make the use of sandpaper unnecessary.

A final part of this course is cabinet-making, designed to give the student work on the planer, universal saw-table, wood-trimmer, scroll-saw, and mortise-machine. After becoming familiar with the different machines, pattern-making is begun, the purpose of this work being to teach the student to make representative types of patterns from which castings may be made. The principles of the shrink rule are explained, and

drawings, such as are used in manufacturing plants, are made in order to teach the use of the finish marks, core boxes, and all conventional signs.

All work is done from drawings.

Prerequisites: Entrance requirements.

Freshman year, first and second terms, two afternoons per week.

2. *Forge Work.**—This course begins with simple exercises in drawing, upsetting, bending, twisting, punching, and welding. The work gradually becomes more difficult, such as making eye-bolts, chains, and tongs. Tool-making is then begun by making screw-drivers, hammers, chisels, and a complete set of lathe tools, which will be used later in the machine shop. This work is fully illustrated by drawings and lectures on the subject, covering the properties of the different grades of iron and steel. The instructors make the student familiar with the best grade of steel to be used for any required purpose, and the correct shape and temper necessary for the best work in cutting iron, steel, brass, and stone. The final and most important part of this work is the testing of rock-drills of different makes, care being taken to preserve the results of the tests on different grades of steel used.

Prerequisite: Course 1.

Sophomore year, two afternoons per week during the entire year.

3. *Metal Work.*—This course begins with chipping to a line, filing to a dimension, and scraping to a surface plate. Machine operation is then begun; the principles and uses of the drill-press, lathe, planer, shaper, and milling machine are taught by lectures followed by practical work at each machine. After a reasonable time, skill is attained in operating the various machines through a course of graded exercises. Students are required to build complete machines designed by upper classmen or by the instructor. In this work use is made

*Students may elect three terms in machine drawing instead of three terms in forge work.

of the vernier micrometer, thread-micrometer, and gear-tooth caliper. The degree of accuracy thus acquired enables the student to use eye and hand in unison, and is a lasting benefit in teaching exactness in statement and measurement.

This is a part of the course in Mining Machinery Laboratory, described as Course 12 in Mining Engineering.

Prerequisite: Course 2 or 5.

4. *Mechanical Drawing.*—The student is first given practice in geometrical construction until he is familiar with the nature, care and use of drafting instruments. Then, after carefully studying the principles of orthographic projection, intersection, and development, he is thoroughly drilled in free-hand lettering. The course is completed with one term of machine drawing. In this the student is required to make sketches, detail and assembly drawings of machines, and is taught the principles of elementary machine design.

Prerequisites: Entrance requirements.

Freshman year, six hours per week throughout the year.

Texts: Anthony, *Mechanical Drawing.*
Wilson, *Free-Hand Lettering; Machine Drawing.*

5. *Machine Drawing.**—This course is a continuation of the work in mechanical drawing of the Freshman year. It includes exercises covering gearing, power transmission, mechanism, and the simpler machines used in mining, ore dressing and metallurgy.

Prerequisite: Course 4.

Sophomore year, two afternoons per week throughout the year.

6. *Descriptive Geometry.*—The usual text-book works is reinforced with daily blackboard exercises in presenting the projections of familiar objects, intersections of plane and curved surfaces, sections, developments, and shades and shad-

*Students may elect three terms' work in the forge room instead of three terms' work in machine drawing.

FORGE SHOP

ows. The afternoons in the drawing-room are spent in solving in neat form the more elaborate exercises.

Prerequisites: College Algebra and Mechanical Drawing.

Freshman year, second and third terms, two recitations per week, and three hours at the drawing board.

Text: Faunce, *Descriptive Geometry.*

ENGLISH.

MR. SCOTT.

Efficiency in oral and in written expression on the part of the engineer is no longer considered among teachers in technical schools a matter of secondary importance. Efficiency in English, like that in any purely technical subject, can be acquired only by a systematic study of the principles underlying the subject, followed by long apprenticeship of practice under judicious criticism.

No credit for advanced standing in English will be given unless the work for which the credit is asked was done in the collegiate department of an accredited college or in the Junior or Senior year of a State normal school.

1. *Theme Work.*—All Freshmen are required to write, throughout the year, short, daily and long fortnightly themes. This work is carefully criticised by the teacher, corrected by the student, and returned to the critic as evidence that the student has profited by the criticisms.

Prerequisites: Entrance requirements.

2. *Rhetoric.*—Phases of this subject, too complex for high school, are studied.

Prerequisites: Entrance requirements.

Freshman year, five hours a week throughout the year.

Texts: Brewster, *Representative Essays on the Theory of Style.*
Pearson, *Principles of Composition.*
Carpenter, *Advanced Composition, and Rhetoric.*

3. *Advanced English.*—All Sophomores are required to write, each month, at least one long theme of not less than a thousand words. The forms of composition represented by these themes will be exposition and argumentation. An equal number of subjects are selected from each form and are criticised in the same manner as the Freshman themes.

The class work in Advanced English will be a critical study of present-day practical articles, which in thought and style are masterpieces. After an article is analyzed as to thought and style, the student will be required to write an original article in imitation of the one studied.

Prerequisites: Courses 1 and 2.

Text: Percival and Jelliff, *Specimens of Exposition and Argument.*

4. *General Science English.*—The major part of the course will consist of the theoretical study of the forms of composition known as exposition and argumentation, with the frequent writing of short and long themes, and occasional oral debates. The study of English and American literature will receive some attention, but the work will be mainly to illustrate ideal exposition and argumentation from the point of view of the present day practical man. A part of one term will be given to the criticism of the language of technical literature as found in scientific journals.

Prerequisites: Courses 1 and 2.

Sophomore year, five hours a week throughout the year, General Science Course.

Texts: Percival and Jelliff, *Specimens of Exposition and Argument.*
Rickard, *Technical Writing.*

MODERN LANGUAGES.

MR. WILKINS.

The great quantity and worth of the technical literature in the French and German languages, added to their value as elements of liberal culture, make at least a reading knowledge of them practically a necessary part of an engineer's education.

The instruction in each language is designed to present the grammatical structure and the pronunciation of the tongue—to give some acquaintance with the masterpieces of its literature, and to confer such facility in translation as will enable the student to read with ease the language in both its literary and its scientific uses.

German (Elementary).—For such students who elect German as the foreign language in their course, and who have not had at least one year of high school German.

Prerequisites: Entrance requirements.

Freshman year, second and third terms, four hours per week.

German (Scientific).

Prerequisite: Elementary German.

Text: Dippold, *Scientific German Reader* and current scientific journals and magazines.

Sophomore year, five hours per week throughout the year.

French (Scientific).—Students who have not had Elementary French will not be permitted to elect this language.

Prerequisite: Elementary French.

Text: Herdler, *Scientific French Reader* and current scientific journals and magazines.

Sophomore year, five hours per week throughout the year.

Spanish.—The growing demand for mining engineers and metallurgists in South and Central America, in Mexico and in

the Philippines, where a knowledge of Spanish is almost an essential qualification, has been met by the establishment of a course in this language in the School of Mines. The natural or conversational method is followed exclusively. The object is to give the student facility in the every-day speech of the people. With the consent of the Faculty, students may elect Spanish as the required modern language.

Prerequisite: Rhetoric.

Text: Hill and Ford, *Spanish Grammar.*

Umphrey's *Spanish Prose Composition* (Third Term).

GENERAL INFORMATION.

Terms and Vacation.

The college year, consisting of thirty-six weeks, exclusive of the Christmas holidays, is divided into three terms. The first term begins September 6 and ends December 22; the second term begins January 3 and ends March 10; the third terms begins March 13 and ends May 26.

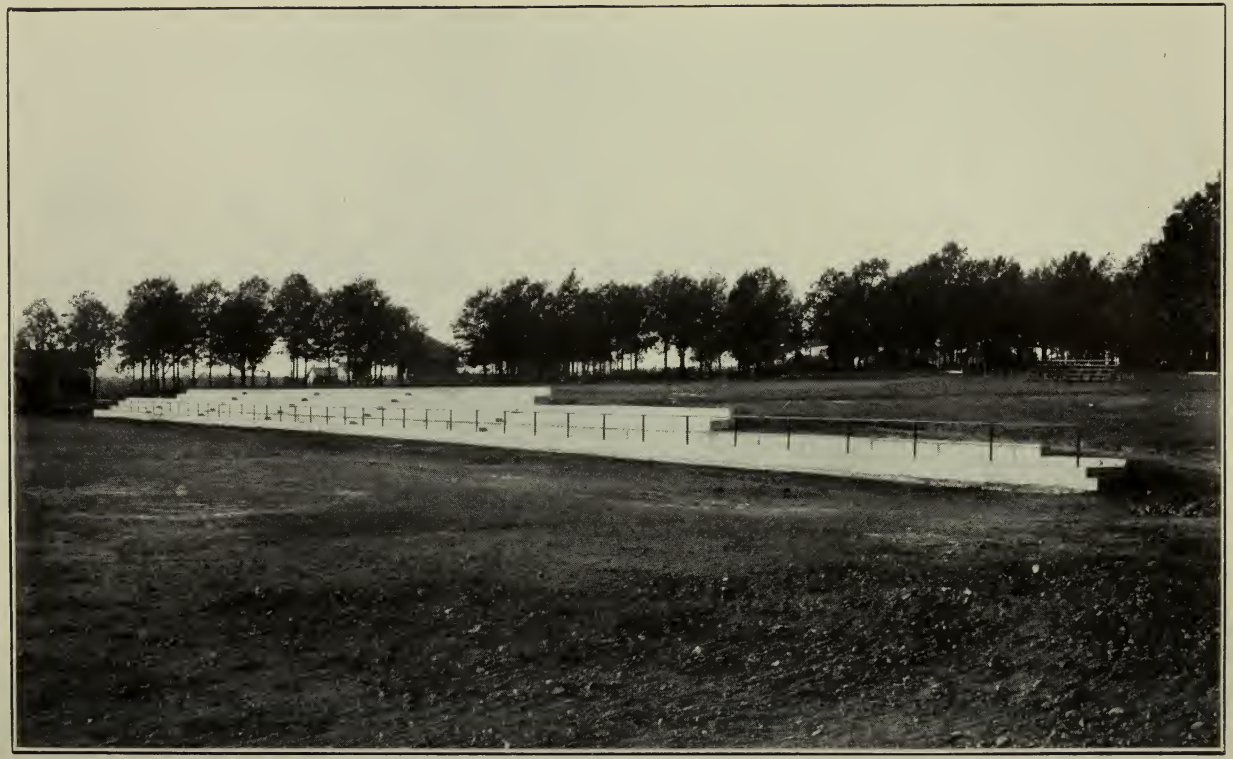
The Christmas holidays intervene between the first and second terms, but there is no interruption of work between the second and third terms. Thanksgiving Day and Washington's Birthday are observed as single holidays.

Excursions.*

The State of Missouri occupies an important place in the mining industry and many opportunities are offered students at the School of Mines and Metallurgy for keeping closely in touch with the mining industry of Missouri and adjoining States. There have been many important developments during the last few years in methods of mining, dressing, and smelting lead and zinc ores. The lead district of southeast Missouri and the zinc district of southwest Missouri offer numerous examples of up-to-date practice in mining and metallurgical engineering. The aggregate tonnage capacity of the concentrating plants of Missouri is greater than that of any other State of the Union. The importance of modern methods of ore dressing is everywhere recognized and the facilities offered by the School of Mines for investigation in ore dressing, together with the practice in concentrating plants which are visited, places the School of Mines and Metallurgy in the foremost rank in this important branch of mine engineering.

Frequent trips and excursions give the student an opportunity to study mining, ore dressing, and metallurgical methods. Field work in metal mine surveying is carried on in suitable mines conveniently located in southeast and southwest Missouri. The practice in coal mine surveying is usually

*See also page 33.



VIEW ON JACKLING FIELD

given in one of the northern Missouri coal mines or in the Illinois field.

The Junior class visits southeast Missouri to study the geology, methods of mining, and the milling of great disseminated lead deposits. The geological work of the Junior trip is especially valuable because of the variety of work introduced. The class has an opportunity to study several varieties of pre-Cambrian rocks of igneous and other origin. Differentiation in magma and intrusions can be seen. The pre-Cambrian topography is discernable in relation to the contact plane between the pre-Cambrian and the Cambrian. Evidence of superimposed drainage is offered. Iron ores of Shepard Mountain, Pilot Knob, and Iron Mountain give interesting study in the distribution and origin of ores. The general relation of the lead ores of the Paleozoic is also studied. The weathering of various kinds of rock in conjunction with jointing and stratification is well illustrated. The Carboniferous basin about St. Louis is given a brief examination. The student should be provided with note-book, compass, clinometer, hammer, and magnifying glass. The observation work of the day is supplemented by evening conferences.

The concentrating plants of southeast Missouri are large and modern, containing crushers, rolls, elevating machinery, Wilfley tables, Frue vanners, jigs, and sundry other machines. The mining plants are thoroughly modern and include steam and electric hoists, modern steel head-frames, compressed air and electric haulage, extensive pumping-plants, and numerous diamond-drill prospecting equipments.

In southwest Missouri the geology, mining, and milling of the shallow deposits as well as of "sheet" ground are studied by the Seniors. Opportunity is given to inspect and study the various types of equipment and methods as adapted to shallow and deeper mining. Many new concentrating plants have been erected and are strictly modern in design and equipment. The application of electric power to mining and milling is well illustrated in this district. Short trips are made to neighboring camps in southeastern Kansas.

During the summer of 1909, a section of the Junior class made a trip to Colorado and Utah, visiting Denver, Idaho Springs, Central City, Georgetown, Silver Plume, Montezuma, Breckenridge, Leadville, Colorado Springs, Cripple Creek, Victor, and Pueblo in Colorado, and Salt Lake City, Garfield, and Bingham in Utah. The work in mine surveying was done at Idaho Springs. Special attention was given to mining practice in the Clear Creek District, the Cripple Creek District, and Leadville and vicinity. Amalgamation was studied in the Clear Creek District; cyanidation at Colorado Springs and Victor; smelting of gold, silver, copper, and lead ores at Leadville and Pueblo; iron and steel metallurgy at Pueblo; treatment of zinc ores at Leadville. Throughout the entire trip the important geological features were noted, a particular study being made of the Garden of the Gods and of the ore deposits of Leadville and of Cripple Creek.

Special attention is paid on these trips to general engineering problems, plant design, economy of operation, and organization.

During the Senior year several trips are made to the metallurgical plants in the vicinity of St. Louis. The plant of the St. Louis Blast Furnace Company illustrates blast-furnace practice. Here may be studied the blast-furnace, regenerative stoves, blowing machinery, power plant, and other appliances necessary for the production of pig iron. Open-hearth steel methods and the manufacture of steel castings is studied at the Scullin & Gallagher Works. This plant includes, in addition to the usual type of open-hearth furnace, Bessemer converters, cupolas, and gas-producers.

The metallurgy of zinc is studied at the Edgar Zinc Works at Carondelet, where the roasting of blende and distillation methods may be seen. The Federal smelter, at Alton, is visited for the study of lead smelting. At this plant the lead blast-furnace, the Huntington-Heberlein roasting system, and the Scotch ore-hearths are carefully inspected. This plant also includes an extensive bag-house. The manufacture of white-lead paint and of lead pipe is seen at the National

Lead Works. A further study of lead smelting is made at Herculaneum, where blast-furnaces are served by Savelsberg pot roasters. At the various plants enumerated, particular attention is paid to the construction of furnaces, the operation of the plant, and the general organization and design.

The manufacture of refractory materials is carefully followed from the mine to the finished product at the plant of the Laclede-Christy Company. This plant is one of the largest clay manufacturing works in the world, and a metallurgist here has a splendid opportunity to investigate refractory products and materials used in the construction of furnaces, stacks, retorts, and crucibles.

These excursions are a required part of the courses and no substitutions are allowed. Every candidate for a degree must take the prescribed excursions as scheduled.

Student Organizations.

The following chapters of college fraternities exist at the School: Gamma Chi of Sigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha, and Missouri Beta of Tau Beta Pi.

The Young Men's Christian Association was organized in the College several years ago, and is growing rapidly. It stands for the best there is in college life and brings together those who believe that college men should develop well-rounded characters, physical, mental, and spiritual. During the opening days of the college, trains are met by association members, who place thmeselves at the service of the new men, helping them to secure rooms and board and to matriculate. The Association occupies the second floor of the Mining Building, where all students are welcomed and regular meetings are held.

The School of Mines Band furnishes music for athletic and outdoor functions and maintains a splendid organization.

The School of Mines Orchestra is reputed, throughout south-central Missouri, as without equal, and furnishes music for all School entertainments, the Commencement Exercises, and gives concerts in nearby towns.

Other Student Organizations include the Glee Club, the Mandolin Club, the Mathematical Club, and the International Club.

The student body publishes a year-book called "The Rollamo." The purpose of this volume is to record the student activities and to present a review of college life at Rolla.

Athletics.

The School encourages rational athletics and has provided an instructor in physical training who has entire supervision of the physical training of students and of all intercollegiate sports. Occasional privileges are granted to athletic teams, but prolonged absences from work are not permitted.

The Jackling Field provides for baseball, football, and other games, and an ample number of tennis courts have been laid out, and are maintained in good order. Suitable dressing-rooms and shower-baths are provided in a temporary building on the athletic field. A gymnasium is provided on the second floor of Mechanical Hall. Suitable gymnasium apparatus is supplied and indoor games can be carried on during the winter months. A general athletic association exists among the students; also football and baseball teams and a tennis club.

Athletic Fee.—Each student is requested to pay a fee of Five Dollars to the Athletic Association of the School.

Expenses.

Tuition Fee.—Tuition is free to all students who are residents of Missouri. At a meeting held in October, 1908, the Board of Curators voted that "From and after September 1, 1909, non-residents of Missouri who matriculate in any Department of the University be required to pay a tuition fee of $20 per year."

Laboratory Fees.—The fees charged are as follows: A library fee of $5 per year, payable upon entrance; a laboratory fee in general chemistry to cover the cost of gas and

supplies; $3 per term for all courses except Metallurgy and Special Mining, for which courses the fee is $10; a laboratory fee in qualitative analysis of $7.50 per term to cover the cost of general supplies and gas; a laboratory fee for quantitative analysis and other Senior and Junior chemical laboratory work, $1.75 per term; a fee of $2.50 per term to cover the cost of supplies for shop work; a fee of $2 per term to cover the cost of supplies in forge work; a laboratory fee of $12.50 per term to cover the cost of supplies in assaying; a laboratory fee of $3 per term to cover the cost of supplies in mineralogy; a fee of $5 per term for Senior metallurgy laboratory; a fee of $2.50 per term for mining machinery laboratory.

Contingent Deposits.—Deposits to cover the cost of extra supplies and damage to apparatus are required of the different classmen as follows: Freshmen, $10; Sophomores, Juniors, and Seniors, $15. These deposits must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

Living Expenses.—The expenses of many students for the entire year do not exceed $250, which will cover in a reasonable manner the fees, cost of books and stationery, board and lodging, and laundry. The cost of field excursions is not included in the above estimate.

Excursion Expenses.—The cost of field excursion will average about $35 per year.

BUREAU OF GEOLOGY AND MINES.

The Geological Survey of the State of Missouri has its headquarters at Rolla, and occupies the Rolla Building on the school campus.

BOARD OF MANAGERS.

Governor Herbert S. Hadley, Jefferson City.....President
Hon. Elias S. Gatch, St. Louis.....Vice-President
Professor Edwin M. Shepard, Springfield.....Secretary
Hon. S. Duffield Mitchell, Carthage.
Hon. J. H. Bovard, Kansas City.

STAFF OF THE GEOLOGICAL SURVEY.

H. A. Buehler.....State Geologist
G. W. Crane .....Geologist
V. H. Hughes .....Geologist
A. X. Illinski.....Chemist
C. C. Baker .....Chief Clerk
W. E. Morse ..... Janitor

Equipment and Investigations.

The Geological Survey has at the present time a library of approximately five thousand volumes and pamphlets on geological and allied subjects and a museum of seven thousand specimens of clay, coal, barite, lead and zinc ore, iron ore, and other mine and quarry products of Missouri.

The Geological Survey is organized principally to aid in the development of the mineral resources of Missouri. Information concerning these resources is gathered through observations in the field by members of the staff. Geologic and topographic maps are prepared of different parts of the State and the various formations are accurately described in accompanying reports. The relation of the geology to the ore

deposits is also worked out and detailed reports published concerning such investigations.

The Department has the following reports available for distribution at the present time:

Preliminary Report.....Vol. XIII.
Geology of Miller County.....Vol. I., 2d series.
Quarrying Industry of Missouri.....Vol. II., 2d series.
Geology of Moniteau County.....Vol. III., 2d series.
Geology of the Granby Area.....Vol. IV., 2d series.
Public Roads .....Vol. V., 2d series.
Lime and Cement Resources of Missouri Vol. VI., 2d series.
Geology of Morgan County.....Vol. VII., 2d series.
Geology of Pike County.....Vol. VIII., 2d series.
Geology of the Disseminated Lead Deposits of St. Francois and Washington Counties, Vol. IX., 2d series.

DEGREES CONFERRED 1909.

Engineer of Mines.

Lewis Alfred Delano, B. S., 1904.
Leo Joseph Foster, B. S., 1904.
Glenn Beckley Morgan, B. S., 1904.
Edwin Phelps Murray, B. S., 1908.
Jesse Herman Steinmesch, B. S., 1906.

Master of Science.

Horace Tharp Mann, B. S., 1908.

Bachelor of Science (Mine Engineering).

Hector George Sylvester Anderson.
John Warren Beard.
Enrique Cavazos.
James Crawford Compton.
George Albert Easley.
Roscoe Conkling Ham.
Victor Harmon Hughes.
Frank Richard Loveridge.
Arthur Lewis Pollard.
William Albert Baueris.
Fred Tete Boyer.
William Danels Clarke.
DeForrest Don.
William Simpson Hall.
Van Buren Hinsch.
Simon Jochamowitz.
William McElroy.
Edgar Joseph Wolf.

Bachelor of Science (Metallurgy).

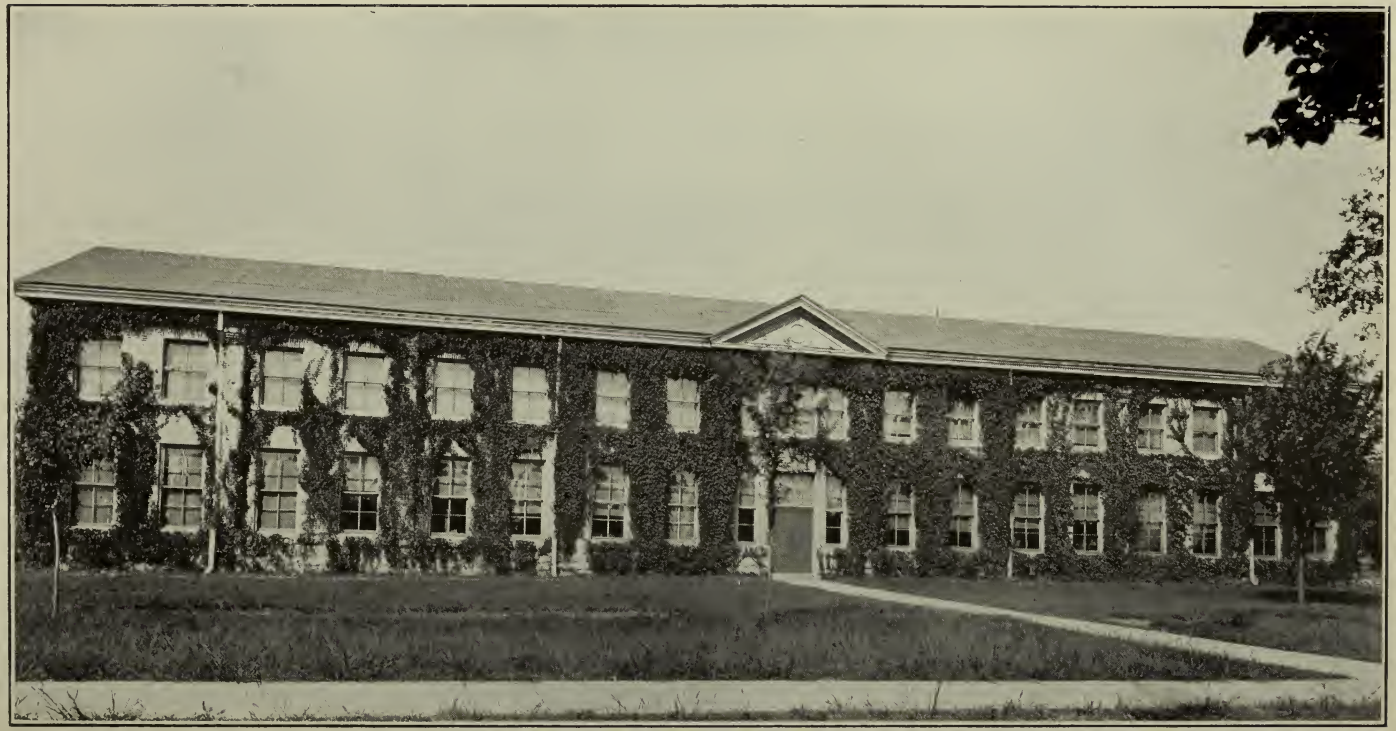
Reginald Henry Brinton Butler.

Bachelor of Science (Civil Engineering).

Ernst Lorenz Chamberlain.
Pearl Frederic Michael.
Harvey Oden Garst.
Frank Xavier Nachtmann.

Bachelor of Science (General Science).

Edward Phillip Barrett.
Roy Hayward DeWaters.
Carl Winthrop Keniston.
Rowe Francis McCrae.
Aaron Max Shah.
William Newton Clark.
Victoriano Elicano.
Harry Clay Kibe.
Mark Stephen Mazany.
Earl McColloch Smith.
Albert Emory Wishon.



MECHANICAL HALL

THESES SUBMITTED IN 1909.

A Method of Obtaining Lead Concentrate from the Slime of a Lead Mill,
LEWIS ALFRED DELANO.

General Method of Procedure in the Working Out of the Uncompaghre Valley Project, Colorado.....LEO JOSEPH FOSTER.

The History and the Development of the Cyanide Industry,
HORACE THARP MANN.

Economic Investigation of the Lignites of the Dickinson, North Dakota, Area .....GLENN BECKLEY MORGAN.

The Relation of the Composition of a Mineral to its Properties,
EDWIN PHELPS MURRAY.

A New Hindered-Settling Classifier.....JESSE HERMAN STEINMESCH.

Minerals and Their Environment of Formation.....DEFORREST DON.

Timbering in the Warren District, Cochise County, Arizona...FRED TETE BOYER.

Technical Analysis of Corn Products.....ROY HAYWARD DEWATERS.

The Microstructure of Drill Steel.....ARTHUR LEWIS POLLARD.

Effect of Certain Minerals on Fire Assay of Lead,
EARL MCCOLLOCH SMITH AND ROWE FRANCIS MCCRAE.

Investigation of Hindered Settling Ratio of Galena, Sphalerite, and Pyrite as Compared with Quartz in Air,
WILLIAM DANELS CLARK AND RALPH WILHEIM WATSON.

The Effect of Arsenic on the Assay of Gold and Silver Ores,
ROSCOE CONKLING HAM.

Desulphurizing or Pot Roasting of Lead Ores.....EDWARD PHILLIP BARRETT.

A Study of Some Problems in Assaying.....AARON MAX SHAH.

Radiation Losses in Metallurgical Furnaces.....FRANK RICHARD LOVERIDGE.

A Study of the Settlement of Slimes,
JAMES CRAWFORD COMPTON AND WILLIAM SIMPSON HALL.

The Influence of Pyrite on the Oxidation of Galena,
WILLIAM NEWTON CLARK AND MARK STEPHEN MAZANY.

Geology Along the St. Louis and San Francisco Railroad from Rolla to Newburg .....VICTOR HARMON HUGHES.

The Construction of a Smelter for the Production of Zinc-White from Western Lead-Zinc Ores,
HECTOR GEORGE SYLVESTER ANDERSON AND VAN BUREN HINSCH.

The Design of a Dam and the Investigation of a Water Supply for the City of Rolla, Missouri,
FRANK XAVIER NACHTMANN AND ERNST LORENZ CHAMBERLAIN.

Design of Reinforced Concrete Water Tower and Tank,
HARVEY ODEN GARST AND PEARL FREDERIC MICHAEL.

The Volatilization and Absorption of Silver Chloride,
EDGAR JOSEPH WOLF AND VICTORIANO ELICANO.

Design and Details of Elevated Steel Water Tower..WILLIAM ALBERT BAUERIS.

A Study of the Losses of Gold During Cupellation in the Presence of Tellurium.....GEORGE ALBERT EASLEY AND CARL WINTHROP KENISTON.

The Construction of the United States Macadam Road at Fort Scott, Kansas .....WILLIAM MCELROY.

A Comparison of the Solvents Used in the Hydrometallurgy of Silver,
SIMON JOCHAMOWITZ AND ENRIQUE CAVAZOS.

The Cyanidation of High-Grade Gold and Silver Concentrate,
REGINALD HENRY BRINTON BUTLER AND JOHN WARREN BEARD.

STUDENTS AT THE MISSOURI SCHOOL OF MINES AND METALLURGY.

1909-1910.

GRADUATE STUDENTS.

Bartlett, Albert Babbitt*.....Cheyenne, Wyo.
B. S. in M. E., 1907, School of Mines.

Chamberlain, Harry Carleton*.....Gila Bend, Ariz.
B. S. in M. E., 1905, School of Mines.

Clary, John Henry*.....Wallace, Idaho.
B. S. in M. E., 1905, School of Mines.

Dudley, Boyd, Jr.....Rolla, Mo.
B. S. in G. S., 1908, School of Mines.

Hunt, Lamar Horatio*.....Pachuca, Mexico.
B. S. in M. E., 1905, School of Mines.

Keniston, Carl Winthrop.....Rolla, Mo.
B. S. in G. S., 1909, School of Mines.

Lintecum, Charles Lafayette*.....Telluride, Colo.
B. S. in M. E., 1905, School of Mines.

Lohman, Harry William*.....Breckenridge, Colo.
B. S. in M. E., 1904, School of Mines.

Lyman, George Edwin.....Edwardsville, Ill.
B. S. in C. E., 1902, School of Mines.

Mann, Horace Tharp.....Rolla, Mo.
B. S. in M. E., 1908, School of Mines;
M. S., 1909, School of Mines.

Phillips, Walter Irving*.....Cheyenne, Wyo.
B. S. in Met., 1907, School of Mines.

Richards, Walter Coffran*.....Fredonia, Ky.
B. S. in M. E., 1907, School of Mines.

Rivera, Ramon*.....Guadalajara, Mexico.
B. S. in C. E., 1906, School of Mines.

Rucker, Ray Fleming*.....Hannibal, Mo.
B. S. in M. E., 1906, School of Mines.

Seltzer, Andrew Jackson*.....Wuchang, China.
B. S. in Met., 1907, School of Mines.

Snyder, Byron John.....Dahlonega, Ga.
B. S. in Met., 1907, School of Mines.

Tseung, Tsik Chan*.....Changsa, China.
B. S. in M. E., 1907, School of Mines.

Wash, Edwin Richard*.....Tombstone, Ariz.
B. S. in M. E., 1907, School of Mines.

* In Absentia.

SENIORS.

Blake, Frank Orris, Jr.....St. Louis, Mo.
Bodman, John Whittlesey.....Kansas City, Mo.
Boland, Earl Frederick.....Syracuse, N. Y.
Bowles, James Joseph.....Lake Springs, Mo.
Branham, William Grover.....Joplin, Mo.
Bunten, James .....Canon City, Colo.
Burdick, Charles Adrian.....Dansville, N. Y.
Caples, Russell Bigelow, Jr.....Glasgow, Mo.
Clark, John Charles.....Chicago, Ill.
Connelly, Harry Wade.....Independence, Kan.
Detweiler, Alfred Nicks.....Lebanon, Mo.
Diaz, Emilio .....Santiago, Chili.
Dobbins, Walter .....Champaign, Ill.
Dosenbach, Benjamin Harrison.....St. Louis, Mo.
Dunn, Theodore Saunders.....Waukegan, Ill.
Farrar, Monroe .....Mattoon, Ill.
Flynt, Frank Le Roy.....Rolla, Mo.
Forman, John Kavanaugh.....McFall, Mo.
Fraser, Keith Colt.....Lyndonville, N. Y.
Gregory, Clay, Jr.....Joplin, Mo.
Harlan, John Dee.....Moberly, Mo.
Heinz, William Frederick.....Achley, Iowa.
Holmes, Oliver Wendell.....Rolla, Mo.
Hynes, Dibrell Pryor.....Cananea, Mexico.
Illinski, Alexis Xavier.....Rolla, Mo.
Jones, William Hamilton.....St. Louis, Mo.
Karte, Anton Frederick.....De Soto, Mo.
Kenney, John Richardson.....Chicago, Ill.
Killian, Ralph Daniel.....Perryville, Mo.
Lass, Charles Abraham.....Agricultural Col., Miss.
List, Elmer .....Cape Girardeau, Mo.
McNutt, Vachel Harry.....Monroe City, Mo.
Mackey, Robert William.....Waukegan, Ill.
Minor, Harmon Edwin.....Canon City, Colo.
Mook, Robert Lee.....St. Louis, Mo.
Morgan, Allen Ray Dearborn.....Rolla, Mo.
Murphy, Benton Franklin.....Bonne Terre, Mo.
Ohnsorg, Norman Lloyd.....Rolla, Mo.
Park, Albert .....Rolla, Mo.
Parsons, Frederick .....Rolla, Mo.
Peterson, Howard Kelsey.....New Rochelle, N. Y.
Pickering, John Lyle, Jr.....Springfield, Ill.
Porri, Louis Joseph.....St. Louis, Mo.

Riede, Frederick Edward.....Canon City, Colo.
Schmidt, Sidney Randolph.....Chicago, Ill.
Schultz, John Elmer.....Topeka, Kan.
Smith, Harvey Edson.....St. Louis, Mo.
Smith, Van Hoose.....Little Rock, Ark.
Stewart, John Sloan, Jr.....Mansfield, Ohio.
Thompson, Reuben Conrad.....Sioux Falls, S. Dak.
Traughber, Charles Weaver.....Centralia, Mo.
Vogt, George .....Davenport, Iowa.
Wander, Ernest .....Chicago, Ill.
Welsh, Harold Llewellyn.....Kansas City, Mo.

JUNIORS.

Abbott, Edward Rees.....Mansfield, Ohio.
Albertson, Maurice .....Aurora, Mo.
Allen, Ernest James.....Forrest, Ill.
Baker, Charles Cameron.....Rolla. Mo.
Beach, James Keller.....Dallas, Texas.
Bingham, Raymond Alexander.....Watertown, Mass.
Blake, True Walter.....Chicago, Ill.
Boza, Hector .....Lima, Peru.
Chase, James Howard.....Logansport, Ind.
Coaske, Paul E.....St. Louis, Mo.
Cody, Benjamin Horace.....St. Joseph, Mo.
Copeland, Robert Nathaniel.....Chelsea, Mass.
Dye, Robert Emmett.....Joplin, Mo.
Elmore, Carlos .....Lima, Peru.
Engelmann, Edward William.....St. Louis, Mo.
Flynn, Frank James.....St. Joseph, Mo.
Ford, Harold Percy.....St. Joseph, Mo.
Forrester, David Lawton.....Oakland, Calif.
Garcia, Herman .....Mexico City, Mexico.
Gilchrist, K. P.....Lathrop, Mo.
Goldman, Jay Maurice.....St. Louis, Mo.
Groves, Frank W.....Des Moines, Iowa.
Harris, Deane Dwight.....Rolla, Mo.
Hirdler, Eva Endurance.....St. Louis, Mo.
James, Ivory Small.....San Antonio, Texas.
Keelyn, James Lawton.....Evanston, Ill.
Kurz, J. Adolph.....St. Louis, Mo.
Lindau, Sam Paul.....Liberty, Mo.
Lunak, Otto Allen.....St. Louis, Mo.
McGoughran, James E.....Rolla, Mo.
Macomber, Sumner Cooley.....Des Moines, Iowa.

Maveety, Roswell Hall.....Cincinnati, Ohio.
Mitchell, Robert Bruce.....Walker, Mo.
Nason, Stanley .....West Haven, Conn.
Owen, Harvey Skidmore.....St. Louis, Mo.
Pudewa, Arthur G.....Chicago, Ill.
Raj, Shiv .....Lahore, India.
Randolph, Oscar Alan.....Kansas City, Mo.
Sheffer, Mark .....Maisonpol, Russia.
Sprague, Roy Elliott.....Farmington, Mich.
Tedrow, Harvey Louis.....St. Joseph, Mo.
Townsend, Frank Edgar.....Belgrade, Mo.
Townsend, Richard H.....Aspen, Colo.
Walker, John Perry, Jr.....Rolla, Mo.
Young, Carl Deuel.....Fargo, N. Dak.
Zimmerman, George Henry.....Romney, W. Va.

SOPHOMORES.

Andrus, D. E.....Rockford, Ill.
Baumbach, John Kenneth.....Maplewood, Mo.
Bilderback, Alexander Scott.....Kansas City, Mo.
Blake, Harold .....St. Louis, Mo.
Bland, John Lilburn.....Lebanon, Mo.
Bribach, Oscar Nicholas.....St. Louis, Mo.
Broughton, Eugene Harding.....Jefferson City, Mo.
Caplan, Frank .....St. Louis, Mo.
Conover, Cairy C.....Carrollton, Mo.
Coover, Louie L.....Springfield, Mo.
Copelin, Leonard Stephen.....Great Falls, Mont.
Cronk, Arthur Harrison.....Omaha, Neb.
Cushwa, Claude .....Independence, Mo.
Elbelt, William Henry.....St. Joseph, Mo.
Fogarty, Edmond Allen.....Sandcliffs, Mont.
Geringer, Otto George.....Chicago, Ill.
Gleason, Augustus William.....Chicago, Ill.
Gray, Walter Berry.....Louisiana, Mo.
Hackwood, Arthur Wellesley.....Baxter Springs, Kan.
Hayes, Dale Irwin.....Rock Island, Ill.
Hecht, Leon Morse.....Nashville, Tenn.
Herndon, Frank .....Lebanon, Mo.
Hollister, Scoville Edward.....Marshall, Mo.
Irwin, Joseph Stewart.....Louisiana, Mo.
Katz, Edgar Douglas.....Kissimmee, Fla.
Katz, Howard M.....Kissimmee, Fla.
Kinney, Robert Noel.....Rolla, Mo.

Kranzthor, Fred ..... Eagle Pass, Texas.
Lightman, Morris ..... Nashville, Tenn.
Lynton, Edward ..... Ipswich, Eng.
Lyons, Clyde ..... Springfield, Mo.
McFadden, Edwin Cook..... Chicago, Ill.
McKibben, Harold Dennis..... Kansas City, Mo.
McNair, Stuart Strathy..... New York, N. Y.
Miller, Winlock W., Jr..... Kansas City, Mo.
Molyneux, Guy M..... Sandpoint, Idaho.
Morris, Edwin Robinson..... Jefferson City, Mo.
Myers, Warren Prescott..... Prescott, Ariz.
Naylor, Arch Waugh..... Marshall, Mo.
Porri, William ..... St. Louis, Mo.
Pratt, George H..... Detroit, Mich.
Radcliffe, Donald Newson..... St. Louis, Mo.
Raible, Norman William..... Hannibal, Mo.
Robinson, Eugene Charles..... Independence, Mo.
Schilling, George William..... Freeport, Ill.
Schmich, Matt, Jr..... Freeport, Ill.
Shaw, Harry ..... St. Louis, Mo.
Shaw, Thomas Edward..... West Haven, Conn.
Sherry, Homer Kent..... Lyndon, Kan.
Smith, Charles Albert ..... Philadelphia, Pa.
Smith, Marshall Raymond ..... Rolla, Mo.
Smith, William Bryce ..... Joplin, Mo.
Stephenson, William Pittman..... Nevada, Mo.
Thomas, George Sylvester..... Chicago, Ill.
Tway, Robert Raymond..... Springfield, Mo.
Ustick, Edward Thomas, Jr..... St. Louis, Mo.
Wemhaner, Oscar Christopher..... Warsaw, Ill.
Willmott, Miller E..... Liberty, Mo.
Wright, Clark Watson..... St. Louis, Mo.

FRESHMEN.

Agnew, Samuel Lester..... Doe Run, Mo.
Barrett, W. H., Jr..... Weir, Kan.
Beach, Philip Sydney..... Prescott, Ariz.
Benham, Willard Miles..... Cobden, Ill.
Bland, Clark C..... Rolla, Mo.
Boucher, Leo ..... Marshalltown, Iowa.
Boyle, John Clarence..... Trinidad, Colo.
Bramson, Charles ..... New York, N. Y.
Brewer, Jesse H..... Batavia, N. Y.
Brewer, William Francis..... Carlinville, Ill.

Brooks, Herbert Ivey.....Sheridan, Wyo.
Brown, Alvin Bovell.....Sedalia, Mo.
Castillon, Tirso .....Torreon, Mexico.
Cepeda, Miguel Leon.....Jimenez, Mexico.
Clayton, Bert .....Rolla, Mo.
Clayton, Charles Yancey .....Hannibal, Mo.
Cody, Frank Wesley.....St. Joseph, Mo.
Dickson, Frank Paul, Jr.....Kansas City, Mo.
Donaldson, James Floyd.....Kansas City, Mo.
Faulkner, Ward .....Checotah, Okla.
Fendorf, Charles Ernest.....Tuscumbia, Mo.
Garretson, Leona Belle.....Rolla, Mo.
Halley, Earl .....Auxvasse, Mo.
Hanes, Neibert Bartram.....Springfield, Mo.
Hopkins, James .....Ramey, Pa.
Houghtlin, William Harry.....Jerseyville, Ill.
Johnson, Frank Lindley.....St. Louis, Mo.
Kadell, Carl Peter.....St. Louis, Mo.
Kline, Annie E.....Rolla, Mo.
Knickerbocker, Gould .....Clymers, Ind.
Leasure, La Vere.....Larned, Kan.
McFarland, Russel .....Crawfordsville, Ind.
Marshall, Holman .....Sioux City, Iowa.
Needles, Enoch Ray.....Kansas City, Mo.
Nowlan, Harry H.....Cheyenne, Wyo.
Runnels, Ralph Willard.....Kansas City, Mo.
Seward, J. F.....Hillsboro, Ill.
Sickly, Robert Glenn.....Iola, Kan.
Smith, Clyde Othello.....Joplin, Mo.
Taylor, Bright Hopkins.....Newport News, Va.
Thrush, Harry Alfred.....Warsaw, Ind.
Tiernan, James Peter.....Kansas City, Mo.
Webster, John Nixon.....Creston, Iowa.
Whiteley, Harold Earl.....Kansas City, Mo.
Wilson, Ernest C.....Mt. Vernon, Ind.

SPECIAL STUDENTS.

Geringer, John Charles.....Chicago, Ill.
Hassett, James Lester.....Papillion, Neb.
James, James Rush.....Springfield, Mo.
Leavitt, James Blaine.....Houston, Mo.
Maxwell, Arthur Byron .....Chico, Texas.
Purdon, Arthur .....St. Louis, Mo.
Roberts, P. A.....Joplin, Mo.
Wilson, James .....El Oro, Mexico.
Wilson, Thomas .....El Oro, Mexico.

ENROLLMENT BY STATES AND COUNTRIES.

Arizona	4
Arkansas	1
California	1
Colorado	7
Connecticut	2
Florida	2
Georgia	1
Idaho	3
Illinois	29
Indiana	5
Iowa	7
Kansas	7
Kentucky	1
Massachusetts	2
Michigan	2
Mississippi	1
Missouri	110
Montana	2
Nebraska	2
New York	7
North Dakota	1
Ohio	3
Oklahoma	1
Pennsylvania	2
South Dakota	1
Tennessee	2
Texas	4
Utah	1
Virginia	1
West Virginia	1
Wyoming	3
Chili	1
China	2
England	1
India	1
Mexico	7
Peru	2
Russia	1
Total	231

ALUMNI.

Alexander, Curtis, '84.....*Garfield, Utah*
Utah Copper Co.

Alexander, Raphael Currier, '03.....*Medicine Lodge, Kan.*

Alexander, Thompson, '01.....*Chaffee, Mo.*
Engineering Department, St. Louis and San Francisco Railroad.

Ambler, John Owen, '06.....*Cananea, Mexico*
Cananea Consolidated Copper Company.

Anderson, Hector George Sylvester, '08.....*Kelvin, Ariz.*
Ray Consolidated Copper Co.

Anderson, Perry Barton, '97.....*Ft. Madison, Iowa*

Armstrong, Richard Edward, '08,
150 N. W. Temple, Salt Lake City, Utah
Engineer, with Utah Consolidated Copper Co.

Baker, Arnold George, '07.....*Chouteau, Mont.*

Baker, Charles Armstrong, '08.....*Ely, Nev.*

Barker, Ralph, '98.....*Chicago, Ill.*

Barrett, Edward Phillip, '09.....*Wilburton, Okla.*
Instructor in Chemistry, Oklahoma School of Mines.

Bartlett, Albert Babbitt, '07.....*Cheyenne, Wyo.*
Consulting Mining Engineer.

Barton, Robert Arthur, '06.....*Vernon, B. C.*

Baueris, William Albert, '09.....*10216 Lowe Ave., Chicago, Ill.*

Bean, William Yantis, '78.....*510 Pine St., St. Louis, Mo.*

Beard, John Warren, '09.....*Care of Ophir Tunnel, Smuggler, Colo.*

Bedford, Robert Hardy, '06.....*Tombstone, Ariz.*
Mining Engineer.

Bell, Frank Rolla, '03.....*Bartlesville, Okla.*

Benedict, Ralph Robert, '08.....*659 Park Ave., Kansas City, Mo.*
City Engineering Department.

Black, James Kenney, '04.....*Clayton, Mo.*
Instructor in Chemistry, Washington University.

Bland, George Vest, '04.....*Sulzer, Alaska*
Superintendent, Sulzer Mine.

Bowles, John Hyer, '08.....*Granby, Mo.*
Assayer, Granby Mining and Smelting Co.

Boyer, Fred Tete, '09.....*3633 Shenandoah Ave., St. Louis, Mo.*
Care of National Lead Co.

Boyer, George Hewitt, '08.....*R. F. D. No. 8, Jefferson Barracks, Mo.*
Chemist, Continental Portland Cement Co.

Brooks, John McMillen, '06.....*Knoxville, Tenn.*

Brown, Joseph Jarvis, Jr., '05.....*Wilburton, Okla.*
Professor of Metallurgy, Oklahoma School of Mines.

Brown, William Ernest, '07.....*Denver, Colo.*

Brown, Wilton Rutherford, '78.....

Buckby, De Nard Wilson, '01.....*Whitehall, Mont.*

Burgher, Mark Bernardi, '06.....*Hannibal, Mo.*
City Engineer.

Buskett, Evans Walker, '95.....*4262 Delmar Ave., St. Louis, Mo.*

Buskett, Mary P., '93.....

Butler, Reginald Henry Brinton, '09,
La Libertad, Jerez, Nicaragua, Central America
Javali Mine.

Cameron, John Simpson, '97.....*Lehigh, Okla.*
Coal Mine Operator.

Caples, James Watts, '05.....*Salmon, Idaho*
Lemhi Engineering Co.

Carnahan, Thomas Samuel, '04.....*P. O. Box 296, Tonopah, Nev.*
General Manager, Tonopah-Liberty Mining Co.

Carson, Arthur C., '80.....*Butte, Mont.*
Manager, North Butte Copper Co.

Cavazos, Enrique, '09.....*Ltd., Mazapil, Zacatecas, Mexico*
Mazapil Copper Co.

Chamberlain, Ernest Lorenz, '09.....*Box 1017, Memphis, Tenn.*
Mississippi River Commission.

Chamberlain, Harry Carleton, '05.....*Gila Bend, Ariz.*
Cornelia Copper Co.

Chamberlain, Santiago, '00.....*Conception Del Oro, Zac., Mexico*
Campania Minera.

Christopher, James Knight, '05,
317 Board of Trade Bldg., Kansas City, Mo.

Clark, George Clough, '99.....*Tucson, Ariz.*
Clark Engineering Company.

Clark, William Newton, '09.....*Ottumwa, Iowa*
Engineer, Phillips Fuel Co.

Clarke, William Danels, '09.....*Garfield, Utah*
Utah Copper Co.

Clary, John Henry, '05.....*Wallace, Idaho*
Moore and Clary, Engineers and Assayers.

Claypool, Wm. M., '84.....*Hollywood, Cal.*

Cole, George W., '87.....
Deceased.

Compton, James Crawford, '09.....*Emporia, Kan.*
Kaw Paving Co.

Conrads, Ralph Augustus, '04.....*El Oro, Mexico D. F., Mexico*
Esperanza Mining Co.

Cook, Eldon Everett, '07.....*Osborn, Mo.*

Cook, Paul Richardson, '07.....*Salt Lake City, Utah*
Engineering Department, Oregon Short Line R. R.

Coppedge, Lindsay L., '78.....
Deceased.

Cowen, Herman Cyril, '95.....*Cementon, N. Y.*

Cowles, Frederick Ragland, '01.....*16 E. 34th St., Kansas City, Mo.*
University Preparatory School.

Cowperthwaite, Thomas, '05.....*Box 794, Warren, Ariz.*
Engineering Department, Calumet and Arizona Mining Co.

Cullings, Jay, '86.....*Pueblo, Colo.*
Assistant Bridge Engineer, A. T. & S. F. R. R.

Cummins, Robert Patrick, '05.....*3835 Page Ave., St. Louis, Mo.*
Engineering Department, Frisco Railroad.

D'Arcy, Arthur Ignatius, '03.....*Mina, Nev.*

Dailey, Cornelius Mark, '02.....*Care of Edward Flad, St. Louis, Mo.*

Davis, Floyd, '83.....*1659 Broadway, Denver, Colo.*
Consulting Mining Engineer.

Dean, George Reginald, '90.....*Rolla, Mo.*
Professor of Mathematics, Missouri School of Mines.

Dean, George Walter, '97.....*La Paz, Bolivia, So. America*
Consulting Engineer, Pan American Tin Co.

Deegan, Francis J., '75.....
Deceased.

Delano, Lewis Alfred, '04.....*Bonne Terre, Mo.*
Assayer, St. Joseph Lead Co.

DeLay, Theo. Stuart, '94.....

De Waters, Roy Haywood, '09.....*St. Louis, Mo.*
Chemist, Bishop Manufacturing Co.

Don, De Forrest, '09.....*Philipsburg, Mont.*
Granite-Bimetallic Consolidated Mining Co.

Draper, James Clark, '01.....*Frisco Bldg., Joplin, Mo.*
Consulting Mining Engineer.

Dudley, Boyd, Jr., '08.....*Rolla, Mo.*
Instructor in Metallurgy and Ore Dressing, Missouri School of Mines.

Duncan, Gustavus A., '74.....*Nelson, Nev.*
Manager, Nevada-Eldorado Mines Co.

Dunkin, Damon Duffield, '04.....*Wilburton, Okla.*
Professor of Mining, Oklahoma School of Mines.

Dwyer, Edward P., '95.....*Joplin, Mo.*
Mine Operator.

Dyer, T., '94.....*Rolla, Mo.*

Eardley, Albert Edwin, '97.....*Carriso Springs, Tex.*

Easley, George Albert, '09.....*La Paz, Bolivia, So. America*
Superintendent, Pan American Tin Co.

Elicano, Victoriano, '09.....*Massinloc, Tambles, P. I.*

Emerson, Cyrus, '76.....*Pittsburg, Kan.*

Ericson, John T. E., '07.....*1227 Caldwell St., Clairton, Pa.*
Chemist, with Carnegie Steel Co.

Fach, Chas. Albert, '00.....*St. Louis, Mo.*

Fay, Albert Hill, '02.....*505 Pearl St., New York, N. Y.*
Engineering and Mining Journal.

Fellows, Aubrey P., '07.....*Collinsville, Ill.*
Chemist, St. L. S. & R. Co.

Fernandez, Abraham Leonardo, '00.....*Monterey, Mexico*

Florreich, Phillip, '95.....*St. Louis, Mo.*
U. S. Engineering Corps.

Foster, Leo Joseph, '04.....*Montrose, Colo.*
U. S. Reclamation Service.

Fowler, James Duncan, '08.....*Montrose, Colo.*
U. S. Reclamation Service.

Fraizer, Isaac Peter, '00.....*Box 652, Salt Lake City, Utah*

French, Chas. Lewis, '08.....*Bisbee, Ariz.*

Fulcher, James E., '86.....*1348 Wilmot St., Ann Arbor, Mich.*
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Gallaher, Phillip C., '84.....*610 Harrison Ave., Leadville, Colo.*
Chemist, Iron Silver Mining Co.

Garcia, John Adrian, '00.....*Old Colony Bldg., Chicago, Ill.*
General Superintendent, Brazil Block Coal Co.

Gardiner, William Alexander, '06.....*El Oro, Mexico*
Esperanza Mining Co.

Garrett, Leon Ellis, '01.....*Rolla, Mo.*
Assistant Professor of Mathematics, Missouri School of Mines.

Garst, Harvey Oden, '09.....*Pocatella, Idaho*
Engineering Department, O. R. & N. R. R.

Garvens, Oscar E., '76.....*E. St. Louis, Ill.*

Gibb, Frank W., '82.....*Little Rock, Ark.*
Gibb and Sanders, Architects.

Gill, John Holt, '74.....
Deceased.

Gill, William Harris, '03.....*Bartlesville, Okla.*
National Zinc Co.

Gormley, Samuel James, '95.....*Lima, Peru, So. America*
Smelter Superintendent, Cerro de Pasco Mining Co.

Gottschalk, Victor Hugo, '98.....*Rolla, Mo.*
Professor of Chemistry, Missouri School of Mines.

Grabill, Lee R., '78.....*Washington, D. C.*
Assistant Engineer, War Department.

Greason, John D., '76.....
Deceased.

Green, Cecil Theodore, '06.....*Rosario, Sinaloa, Mexico*
Care of Minas del Tajo.

Greenidge, Samuel Marshall, '02.....*Cananea, Mexico*
Cananea Consolidated Copper Co.

Gregory, James Albert, '05.....*Rolla, Mo.*

Grether, Walter Scott, '06.....*Care of Hotel Tooele, Tooele City, Utah*
International Smelting and Refining Co.

Griffith, William Thomas, '06.....*St. Louis, Mo.*

Grine, Harry Adam, '04.....*3627 Weber Road, St. Louis, Mo.*

Grove, Claude Devlin, '94.....*Marblemount, Wash.*
Skagit Queen Consolidated Mining Co.

Guntley, Edward Anthony, '06.....*McGill, Nev.*

Hall, William Simpson, '09.....*Pachucha, Hdgo., Mexico*
Sampler, Real del Monte, Minas Barron.

Ham, Roscoe Conkling, '09.....*Warren, Ariz.*

Hand, Horace Alonzo, '06.....*St. Lake City, Utah*

Hanley, Herbert Russell, '01.....
Deceased.

Hare, Almon W., '75.....
Deceased.

Harper, Frank William, '08.....*Courtland, Ariz.*
Chief Chemist, Great Western Mining Co. and C. & A. Mining Co.

Harris, Geo. W., '04.....*Guanajuato, Mexico*
Peregrina Mining and Milling Co.

Hartzell, Henry H., '06.....*Granby, Mo.*
Smelter Superintendent, Granby Mining and Smelting Co.

Hase, Herman Carl, '08.....*Morenci, Ariz.*

Hatch, William Peter, '07.....*Kansas City, Mo.*

Hatchett, Roger Hansom, '99.....

Hauenstein, Frederick, '03.....*Beatty, Nev.*
Locating Engineer, Los Vegas-Tonepah R. R.

Heck, Elmer Cooper, '05.....*Hermosillo, Son., Mexico*
Verde Grande Copper Co.

Hendricks, James Otto, '99.....*Bolivar, Mo.*

Herdman, George Walker, '94.....*Neosho Falls, Kan.*

Hinsch, Van Buren, '09.....*Wilburton, Okla.*
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Hoffman, Ray Eugene, '05.....*Hannibal, Mo.*
Assistant Engineer, Atlas Portland Cement Co.

Horner, Preston King, '06,
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Hoyer, Rudolph C., '79.....*Montgomery, Ala.*
U. S. Engineer Office.

Hughes, Victor Harmon, '09.....*Rolla, Mo.*
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Hunt, Lamar Horatio, '05,
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Hynes, Dibrell Pryor, '08.....*Cananea, Mexico*
Sampler, C. C. C. Co. Concentrator.

Jackling, Daniel C., '92.....*Salt Lake City, Utah*
General Manager, Utah Copper Co.
President, Ray Consolidated Copper Co.

Jochamowitz, Simon, '09.....*62 Rue Maubenge, Paris, France*
Graduate Student, Royal School of Mines.

Johnson, Edward Mackay, '92.....*Golden, Colo.*
Chemist, Golden Smelter.

Johnson, Horace Asahel, '08.....*Millers, Nev.*

Jones, Elston Everett, '08.....*Globe, Ariz.*

Jones, Fayette Alexander, '92,
Room 4, Armijo Bldg., Albuquerque, New Mexico
Consulting Mining Engineer and Geologist.

Kellogg, George Fred, '08.....*Skidmore, Mo.*

Keniston, Carl Winthrop, '09.....*Rolla, Mo.*
Station Assistant, Mining Experiment Station.

Kersting, Felix John, '97.....*Columbia, Mo.*
State Highway Commission.

Kibe, Harry Clay, '09.....*Newburg, Mo.*
Superintendent, Newburg Mining and Milling Co.

King, Charles Leclair, '04,
Cia De Real Del Monte y Pachuca, Pachuca, Mexico

Kirkham, John Edward, '95.....*Ames, Iowa*
Associate Professor of Civil Engineering, Iowa State College.

Koeberlin, Frederick Richard, '01.....

Lachmund, Oscar, '87.....*Newhouse Bldg., Salt Lake City, Utah*
Consulting Mining Engineer.

Laizure, Clyde McKeever, '05.....*Millers, Nev.*
Chas. C. Moore & Co.

Lehman, John Ludwig Gustav, '05.....*Monett, Mo.*

Lintecum, Charles Lafayette, '05.....*Telluride, Colo.*
Engineer, Liberty Bell G. M. Co.

Logan, Louis Sublettle, '03.....*408 N. 11th St., St. Joseph, Mo.*

Lohman, Harry William, '04.....*Breckenridge, Colo.*
Manager, Colorado Gold Dredging Co.

Long, James Carter, '07.....*Victor, Colo.*

Loveridge, Frank Richard, '09.....*7802 Vermont St., St. Louis, Mo.*
Chemist, with Continental Portland Cement Co.

Luther, Walter Adams, '03.....*St. James, Mo.*

Lyman, George Edwin, '02.....*Edwardsville, Ill.*
Chief Engineer, Madison Coal Corporation.

Lyneman, Felix Anthony, '08.....*Box 712, Denver, Colo.*

McCarthy, John Henry, Jr., '05....*6609 Florisant Ave., St. Louis, Mo.*

McCrae, Rowe Francis, '09.....*Garfield, Utah*
Utah Copper Co.

McElroy, William, '09.....*Ft. Scott, Kan.*
City Engineer.

McGrath, John E., '76.....*Washington, D. C.*
Coast and Geodetic Survey.

Mann, Horace Tharp, '08.....*Rolla, Mo.*
Instructor in Metallurgy, Missouri School of Mines.

Mapes, Harold Thomas, '08....*La Muta No. 501, Mexico D. F., Mexico*
Oaxaca Iron and Coal Co.

Martin, Walter Guy, '96.....*Denver, Colo.*
Ore Purchasing Agent, United Zinc and Chemical Co.

Martinez, Carlos Efrin, '02.....*Saltillo, Coah., Mexico*
Saltillo Light Co.

Martinez, Justo G., '86.....

May, Lawrence, '02.....*Winthrop, Cal.*
Bully Hill Copper Mining and Smelting Co.

Mazany, Mark Stephen, '09.....*Garfield, Utah*
Foreman, Converter Department, Garfield Plant, A. S. & R. Co.

Michael, Pearl Frederic, '09.....*Rolla, Mo.*

Millard, Sallie E., '91 (Mrs. Cornelius Roach)....*Jefferson City, Mo.*

Millsap, Thos. H., '77.....
Deceased.

Minger, Wm. C., '76.....*Idaho Springs, Colo.*
Assayer, Chamberlain-Dillingham Sampling Co.

Minor, Cyrus Edward, '04.....*Cananea, Mexico*
Cananea Consolidated Copper Co.

Mix, Ward Barr, '08.....*Edwardsville, Ill.*
Engineering Department, Madison Coal Corporation.

Moore, Frederick Arnold, '08.....*Herculaneum, Mo.*
Assistant Superintendent, St. Joe Lead Co.

Moore, Stanley Ralston, '05.....*Wallace, Idaho*
Moore and Clary, Engineers and Assayers.

Morgan, Glenn Beckley, '04.....*Box 138, Fargo, N. D.*
U. S. Geological Survey.

Morris, Edmund James, '02.....
Deceased.

Mortland, Ernest Albert, '01.....*Hardin, Ill.*

Murray, Edwin Phelps, '08.....*Wallace, Idaho*
Engineering Department, Federal Lead Co.

Nachtmann, Frank Xavier, '09.....*Joplin, Mo.*
Engineering Department, Frisco R. R.

Neer, Don Morgan, '08.....*Winfield, Kan.*

Nesbitt, William Corsey, '05.....*Colorado Springs, Colo.*

Neustraedter, Arthur, '84.....*283 Virginia Ave., Jersey City, N. J.*

Norton, Benjamin Newton, '02.....*Douglas, Ariz.*

Nye, Alfred Leo, '08.....*Pachuca, Hidalgo, Mexico*
Real del Monte, Minas Barron.

Ohman-Dumesnil, A. H., '77.....*3553 Park Ave., St. Louis, Mo.*

Olmsted, George Lewis, '01.....*Doe Run, Mo.*

Owen, John R. D., '85.....
Deceased.

Pack, James A., '77.....*De Lamar, Idaho*

Pack, John Wallace, '74.....*San Francisco, Cal.*
Assayer, U. S. Mint.

Painter, William R., '82.....*Carrollton, Mo.*
Editor.

Perkins, Edwin Thompson, '99.....*Granby, Mo.*
Underwood and Perkins, Mining and Metallurgical Engineers.

Perkins, Fred Hough, '99.....*Flagstaff, Ariz.*

Perkins, William Crutcher, '07.....*Plattsburg, Mo.*

Phelps, Tracy Irwin, '06.....*River Portal, Colo.*
Reclamation Service.

Philippi, Paul Andrew, '08.....*5165 Maple Ave., St. Louis, Mo.*
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Phillips, Walter Irving, '07.....*Cheyenne, Wyo.*
Engineer, with Bartlett Engineering Co.

Pickles, John Lewis, '02.....*1310 River St., El Paso, Tex.*

Pollard, Arthur Lewis, '09.....*35 Bank St., Batavia, N. Y.*
Chemist, with Lackawanna Steel Co.

Powell, Frank Bowman, '06.....*Rolla, Mo.*
Lumber Merchant.

Powell, Walbridge Henry, '01.....*St. James, Mo.*
Lumber Merchant.

Price, Evan Edmund, '04.....*Bingham Canon, Utah*
Ohio Copper Co.

Price, John Morgan, '04.....*La Plata, Colo.*

Prugh, Julian Insco, '05.....*Banning, Cal.*
Gold Park Mining Co.

Quinn, Matthew Vincent, '05.....*Quartzburg, Idaho*
Belshazzar Mining Co.

Reid, John Calum, '93.....*McAlester, Okla.*
General Manager, The Great Western Coal and Coke Co.

Rex, Harry Noel, '02.....*Douglas, Ariz.*

Rice, John Turner, '04.....*1615 Emmet St., Omaha, Neb.*

Richards, Walter Coffran, '07.....*R. F. D. No. 2, Fredonia, Ky.*
Superintendent, American Fluorspar Co.

Rivera, Ramon, '06..*Aranzazu No. 116, Guadalajaro, Jalisco, Mexico*
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Rogers, Herbert Fordyce, '99.....*2914 Louisiana Ave., St. Louis, Mo.*

Rogers, John A., '03.....*Bland, New Mexico*
Engineer, Cochite Gold Milling Co.

Rolufs, Rulof Theodore, '01.....*Herculaneum, Mo.*
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Sandford, John Joseph, '08.....*Dansville, N. Y.*

Schrantz, Ashnab B., '82.....

Schroeder, John Severin, '04.....*Peabody, Kan.*

Schulze, Hermann Otto, '99.....*Wonder, via Fairview, Nev.*

Schulze, Eugene Victor, '03.....*Bisbee, Ariz.*

Scott, John Bennett, '07.....*Rolla, Mo.*
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Seamon, Frank Henry, '91.....*El Paso, Tex.*
Commercial Chemist and Assayer.

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Sedivy, Miles, '08.....*Garfield, Utah*

Seltzer, Andrew Jackson, '07.....*Wuchang, Province of Hupe, China*
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Shah, Aaron Max, '09.....*Vilna, Russia*

Shanks, John Dozier, '06.....*823 N. 3d St., St. Louis, Mo.*

Sheldon, Wilbur Elihu, '05.....*Sterling, Colo.*

Smith, Charles Dosh, '05.....*Webb City, Mo.*
Superintendent, Coahuila Mining Co.

Smith, Earl McColloch, '09,
Constancio Mine, Cape St. Gracias, Nicaragua, Central America

Smith, Lorin X., '80.....*Houston, Mo.*

Snyder, Byron John, '07.....*Dahlonega, Ga.*
Professor of Mining and Electrical Engineering, North Georgia Agricultural College.

Soest, Walter Ernest, '99.....*Chihuahua, Mexico*
Superintendent, Chihuahua Copper Co.

Spencer, Clifton Bates, '93.....*Joplin, Mo.*
Resident Engineer, St. L. and S. F. R. R.

Spengler, Albert, '01.....*2626 Holly St., Denver, Colo.*

Stauber, Ignatius Joseph Henry, '01.....*Silver City, New Mexico*
Manager, Savanna Copper Co.

Steinmesch, Jesse Herman, '06.....*Desloge, Mo.*
Assistant Superintendent, Desloge Cons. Lead Co.

Stevens, John Vivian, '06.....*Los Lunas, New Mexico*
Southern Irrigation, Land and Power Co.

Stewart, Arthur J., '91.....*Tecalitlan, Jalisco, Mexico*

Summers, Edward B., '81.....

Sunada, Sakuhei, '07.....*143 Michigan Ave., Chicago, Ill.*

Taylor, Howard Joshua, '99.....*Abbingdon, Ill.*

Taylor, Joseph MacFerran, '05.....*Philadelphia, Pa.*

Tayman, Francis Joseph, '99.....*Los Grados, Guerrero, Mexico*
Mine Superintendent, Los Grados Incorporated.

Terrell, Arthur Davis, '98.....*De Pue, Ill.*
Mineral Paint Zinc Co.

Thomas, Alfred Augustus, Jr., '05.....*Springfield, Mo.*

Thomas, Wm. Stephens, '94.....*Bevier, Mo.*

Thompson, Robert Clair, '04.....*Wilburton, Okla.*
Professor of Chemistry, Oklahoma School of Mines.

Thornhill, Edwin Bryant, '08.....*Salmon City, Idaho*
Lemhi Engineering Co.

Torrence, Euart Carl, '98.....*Pocahontas, Mo.*

Torrence, Leslie Clay, '97.....*Pocahontas, Mo.*

Tseung, Tsik Chan, '07.....*Changsha, Hunan, China*
Instructor, Polytechnic School.

Tweed, Walter James, '04.....*Houston, Mo.*

Tyrrell, Frank Lee, '92.....*Salem, Mo.*

Underwood, Jerrold Roscoe, '99.....*Granby, Mo.*
Underwood and Perkins, Mining and Metallurgical Engineers.

Van Devander, Hermann Neff, '82.....*Cedartown, Ga.*

Van Frank, Phillip R., '85.....*Little Rock, Ark.*
Assistant Engineer, U. S. Government.

Vitt, John Thomas, '07.....*Union, Mo.*

Walker, John Edward,'03, *Room 702, E. P. & S. W. Bldg., El Paso, Tex.*

Walsh, Francis Henry, '02.....*Guanajuato, Mexico*
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Wash, Edwin Richard, '07.....*Box 147, Tombstone, Ariz.*
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Watkins, Joseph Clarence, '01.....*Joplin, Mo.*

Webster, Royal Sylvester, '03.....*Havana, Cuba*
Havana Central Railroad.

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Weigel, William Melvin, '00.....*State College, Pa.*
Assistant Professor of Mining, Pennsylvania State College.

Wiles, George B., '87.....

Wilfley, Clifford Redman, '05.....*Hostotipaquillo, Jalisco, Mexico*
Cabrera Mines.

Wilson, Albert Dyke, '02.....*148 Rutger St., St. Louis, Mo.*

Wilson, Frank Lewis Leonard, '08.....*McGill, Nev.*
Steptoe Valley Smelting and Mining Co.

Wilson, Frank Walter, '84.....*London, England*

Wilson, Fremont, '85.....*Marion, Ind.*
Division Engineer.

Winters, Chas. F., '79.....*Los Angeles, Cal.*
Teller, National Bank.

Wishon, A. Emory, '09.....*Fresno, Cal.*
San Joaquin Light and Power Co.

Wishon, Walter W., '81.....*Austin, Nev.*
Austin Manhattan Consolidated Mining Co.

Wolf, Edgar Joseph, '09.....*Somerville, N. J.*
Chemist, Alpha Copper Co.

Wood, Clyde Rex, '08.....*Pachuca, Hidalgo, Mexico*
Real del Monte, Minas Barron.

Woodhall, Geo., Jr., '01.....*Denver, Colo.*

Woods, Clarence, '04.....*Blair, Nev.*
Valcalda Mine.

Wright, Ira Lee, '07.....*Silver City, New Mexico*
Savanna Copper Co.

Wyman, William Charles, '06.....*Ottumwa, Iowa*
Anchor Coal Co.

Yeater, Merritt W., '86.....*Sedalia, Mo.*
Contractor.

Zirulick, Hyman, '08.....*Minsk, Russia*

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